HANDBOOK OF

OPERATIVE SURGERY

WITH CHAPTERS ON
TROPICAL SURGERY AND INSTRUMENTS

BY

K. K. CHATTERJI, F. R. C. S. I.,
Bengal Medical Service

FELLOW OF THE ROYAL ACADEMY OF MEDICINE IN IRELAND ; TEACHER OF
DESCRIPTIVE AND OPERATIVE SURGERY AND SURGEON AND DERMATOLOGIST, CAMPBELL
MEDICAL SCHOOL AND HOSPITAL, CALCUTTA ; EXAMINER IN SURGERY, CALCUTTA
UNIVERSITY AND THE STATE MEDICAL FACULTY OF BENGAL.

WITH
193 ILLUSTRATIONS AND 4 COLOURED PLATES

SECOND EDITION,
REVISED AND ENLARGED.

FOREWORD TO THE FIRST EDITION.

THE Teacher of Surgery gradually realises that if his teaching is to bear fruit, the presentation of his subject must be clear, concise, yet full—arranged for easy reference and repetition. The art of teaching operative surgery is to be able to make the student visualise the parts he is to operate on. He must be anticipating meeting with structures, not surprised to find them, and he must learn the handicraft, the sleight of hand of his calling if he is to be dexterous. This book has been written with these objects, and all teachers will welcome its advent.

ROBERT BIRD.

MEDICAL COLLEGE,
   Calcutta.
      1916

नवा नवा हि तं वै
आचार्य्यस्य परं पदं
अद्धयापरयोपेतः
अर्पयामि प्रयत्नतः ॥

— ग्रन्थकारः

PREFACE TO THE SECOND EDITION.

THE first edition of this book was exhausted within a few months of its publication. I owe an apology to medical students and the profession for not being able to respond to their call for a new edition at an earlier date. The rapid sale of the first edition took me by surprise, but as I was by then preparing another book and had involved myself in some original research work, the revision of this book had to be postponed. In the present edition the text has been entirely re-written and considerably enlarged and more than a hundred illustrations have been added.

Two chapters on tropical surgery and two on surgical instruments have been added, while new matter has been freely brought into other chapters. A glossary of B. N. A. terminology has been affixed to the book.

I am grateful to my teacher, Major-General Sir R. Havelock Charles for his kindness in making over to me his valuable materials on tropical and operative surgery ; I have utilised but some portion, conserving the major portion for a future publication.

I am indebted to my former pupils Messrs. N. C. Chatterjee, M.B., D.T.H., Ramanuja Chakravarti and Probhat K. Chatterjee for their valuable help in preparing the manuscript and ready assistance in indexing the text.

To Lt.-Col. A. Leventon, F.R.C.S.I., I.M.S. I must express my indebtedness for kind suggestions and advice which he has ungrudgingly extended to me.

My publishers have been good enough to place their large resources unreservedly at my disposal and the book has been printed almost in record time.

CALCUTTA.   K. K. C.
February, 1921.

PREFACE TO THE FIRST EDITION.

IN preparing this little book, it has been my endeavour to give aid and guidance to Students and Teachers of Surgery. Of course in a work of this size it is not possible to describe all the different methods of each operation, therefore, I have given details of the one which I have found in my experience to give the best results.

I may add that this Handbook of Surgical Operations is chiefly based on the lectures I have been in the habit of delivering to my students at the Campbell Medical School.

The many works on Surgery to which I have referred are mentioned in the List of Authors.

I wish to express my indebtedness to Drs. Ramanuja Chakravarti and Norendra Nath Ghosh, two of my former pupils, for assistance with this work while in the press, and also to Mr. H. M. Rogers of the Medical Department of Messrs. Butterworth & Co., for reading through the proof sheets and for many valuable suggestions.

I shall welcome any criticisms for use in future editions, if called for.

K. K. C.

74, DHARAMTALA,
    CALCUTTA,
    November, 1916.

Chapter XXVIII.

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Chapter XXX.

Chapter XXXI.

LIST OF ILLUSTRATIONS.

CHAPTER I.

Preliminary Remarks.

THE responsibilities of an operation are shared by the operator and his assistants even as they share the credit of a satisfactory result from it. The operator uses his judgment and discretion in selecting his assistants : the chief assistant, the one in charge of instruments and the other in charge of dressings. Order can be maintained by the operator giving definite instructions and by the assistants following them rigidly. In order to carry on the work smoothly, there should be a sense of mutual understanding and co-operation between them. From the time of the preparation of the patient to the completion of the operation and subsequent dressing of the wound, asepsis and antisepsis have to be maintained, and all possible sources of sepsis should be eliminated by the united efforts of all concerned. A careful consideration of indications and contra-indications for operations, attention to the minutest details of technique, untiring patience and thoroughness will help to bring the operation to a successful issue. These are moments of intense concentration when each one of the operating team exerts all his faculties and instincts to attain one goal, that is, completing the operation with quickness and thoroughness. The best assistant is he who knows how to get surgically clean and keep clean, is foresighted and resourceful and is steady and patient. Such an assistant has learned to obey ; he is quick but not in a hurry ; he does his part but is not meddlesome ; he keeps the field of operation clean but his hands away from it. He knows the stages of operations, anticipates events, follows the operator at every step, and has the right thing ready at

C, OS   I

the right moment. He understands the operator's unspoken language.

The operator is quick, cool and deliberate. He knows every step of the operation. He knows what he may find and what he may not find. He follows a definite plan for each operation. It would be as well if he discusses the operation before and after it is completed. He selects his instruments on the previous evening and makes them over to the instrument assistant. These are sterilised the same evening, dried with sterilised towels and put by covered in a sterilised towel. These are re-sterilised on the following morning. He limits the number of instruments to his requirement ; the fewer the number of instruments and simpler they are the better. They are brought to the table in one lot ; this avoids unnecessary rush and bustle during an operation.

Instrument assistant arranges them on the table in a definite order : he knows where he has placed a particular instrument and passes it to the operator with the Cheatle forceps and in its absence holds it between his fingers in such a way that the part of the instrument which is most likely to come in contact with the wound is not being touched. He does not pass a cutting instrument like a scalpel to the operator, or receive it back from him ; the operator picks it up and replaces it himself.

Use of the knife.—The correct way of holding a knife is learnt by observing a surgeon while operating. There are three methods generally adopted.

1. Violin-bow method.—This is the best method in order to judge the amount of force exerted and gauge the depth of the desired incision. The cut is made with the belly which is the sharpest part of the knife (Fig. 3).

2. Dinner-knife method.—Keep the forefinger on the back of the blade : this is suitable when cutting into hard tissues, *e.g.*, the sole of the foot or when cutting through the soft tissues down to the bone (Fig. 4).

3. **Pen-holder method.**—This is useful for fine dissection, *e.g.*, separation of delicate structures such as nerves and veins from arteries. Accurate movement is ensured as the hand is steadied by resting on the little and ring fingers (Fig. 5).

Fic. 1.   Fig 3.   Fig. 2.
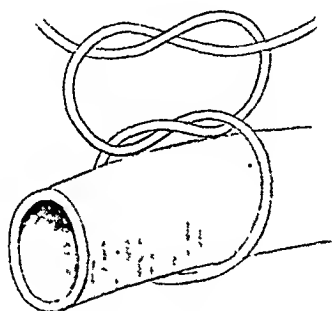
Reef-Knot
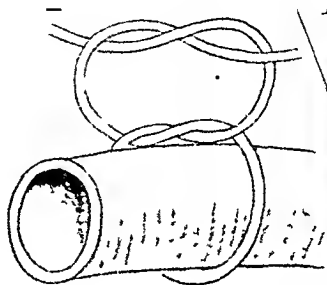
Granny-Knot
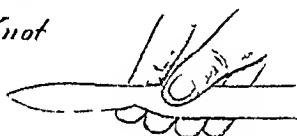
Violin bow method
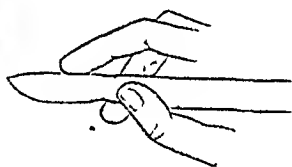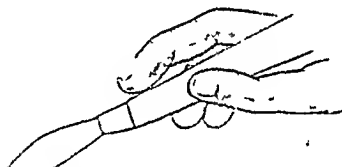
Dinner Knife method   *Penholder method*

Fig. 4.   Fig. 5.

4. For circular amputations grasp the handle of the knife with the whole of the palm.

Comment.—Do not pick with the point of the knife. Do not scrape with the blade of the knife. Do not use the handle of the knife for separating structures.

INCISIONS.

For skin incisions.—Steady the skin with the left hand by stretching it between the forefinger and the thumb,

otherwise the edges will be serrated especially in lean patients.
Enter the skin vertically with the point of the knife, then cut
with the belly of the blade throughout the whole length and
withdraw the knife in the same position as it had entered and
thus avoid tailing of the incision. Avoid superficial veins as
far as possible. The incision has to be longer in a fat patient
than in a thin one, it must be long enough to expose the deeper
parts so that there may not be unnecessary dragging on the
edges with retractors.

For deeper parts.—The deep fascia and soft parts
should be divided in the whole length of the skin wound, other-
wise there will be a funnel-shaped wound which must be
avoided. Cutting muscles across their fibres should be avoided
as far as possible ; dividing or splitting between the fibres should
be practised. Incisions should be clean cut ; blunt dissection
should be avoided.

SUTURES.

1. Interrupted suture.—Each stitch is passed and
tied off separately, the interval between each suture
depends on the nature of apposition that is desired. Leave
the knots on one or the other side of the line of incision
(Fig. 7).

2. Continuous suture.—It is begun by making a stitch
at one end of the wound and knotting it off. It is carried from
side to side at regular intervals till the other end is reached
where it is completed by another knot, adjusting the tension
accurately by pulling up each loop in turn (Fig. 6).

3. Blanket suture.—It is a continuous suture in which
each loop is caught up with the needle (Fig. 8).

4. Subcutaneous suture.—The needle pierces the
deeper layers of the skin and subcutaneous tissue of the
wound from side to side. for the whole extent of the wound.
Free ends of the suture (silk worm gut) are left outside
the wound through the. skin and by pulling on these ends,
accurate apposition of the edges is brought about. It leaves
less scar.

PLATE I.
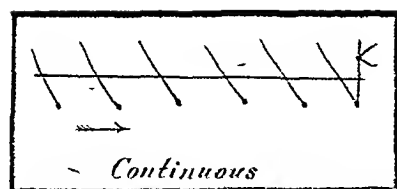
FIG. 6.
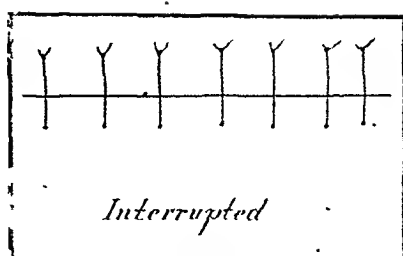
FIG. 7.
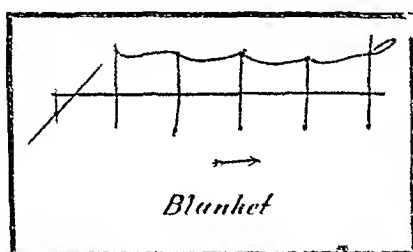
FIG. 8.
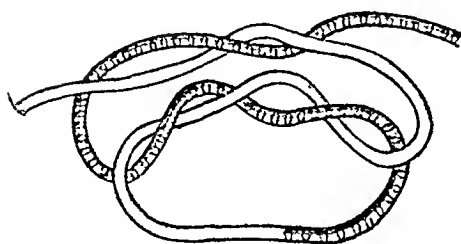
Surgeon's Knot.

FIG. 9.

5. Michel's metallic clip sutures—Are also good: they leave least scar and allow drainage without using tube or capillary drains. (Fig. 118.)

6. Tension suture.—If there is a tendency of the wound to gape, due to tension, it can be prevented by applying the mattress suture. This is done by inserting the suture about three-quarters of an inch away from one margin of the wound, and emerging it at a corresponding point on the other side ; it is then carried back in the opposite direction in a similar way, keeping an interval of about three-quarters of an inch between the points of entrance and emergence on either side (Fig. 11).

7. Intestinal sutures.—*Vide infra.* (Figs. 62, 63).

LIGATURES.

1. The Reef or Sailor-knot—Should be used in ligaturing arteries as a terminal ligature in continuity ; this does not slip (Fig. 1).

2. The Granny knot—May get untied and is more liable to slip (Fig. 2).

3. The Surgeon's knot—Is made by doubling the first turn of the reef knot. It is least likely to slip, nor can the first turn get slack when the second turn is being made (Fig. 9).

4. The Staffordshire knot.—Pass a double ligature through the pedicle. Pass the loop over the tumour or organ and then pass one of the ends of the ligature above the loop and the other below. Pull the ends of the ligature tight and tie. Bring the ends round to the other side and tie again if necessary (Fig. 12).

5. The Transfixion ligature—Is used in ligaturing a pedicle, *e.g.*, of tumours, kidney or for castration. Pass a looped ligature through the centre of the pedicle with an aneurysm needle ; pull out the loop and divide it, tie separately and finish off by taking it round the whole pedicle and tying it. Each half of the pedicle has thus a separate ligature

PLATE II.
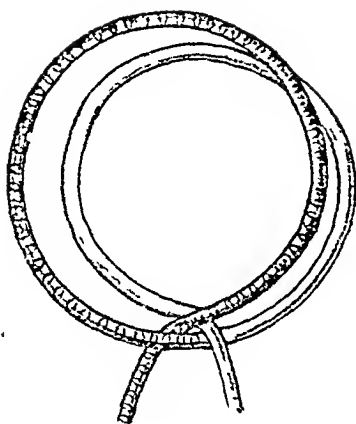
Clove Hitch.

FIG. 10.
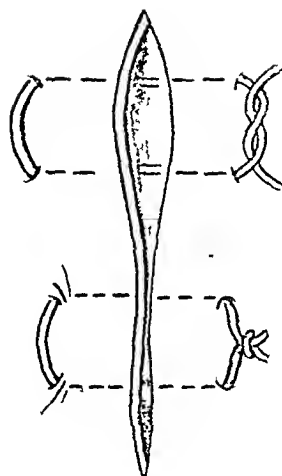
Tension Suture.

FIG. 11.
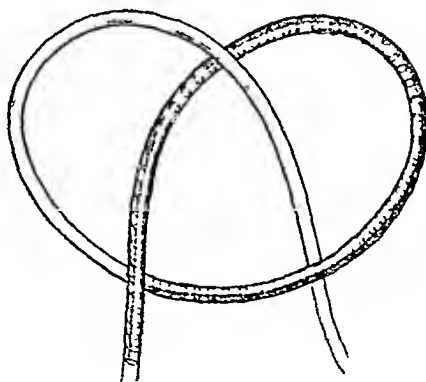
Staffordshire Knot.

FIG. 12.

round it and the whole pedicle is further secured by another ligature.

6. Under-running ligature.—Pass a threaded curved needle through the tissues or skin deeper to the vessel, bring it out on the other side and tie off ; it is useful for bleeding vessels of the scalp and in amputation of the penis.

The *clove hitch* is not used for ligaturing a vessel but for supporting, suspending or pulling a limb. It has an advantage that it does not cause undue constriction on the limb. It is made by placing two successive loops with a bandage, one being kept behind the other (Fig. 10).

CHAPTER II.

LIGATION OF ARTERIES.

Preliminary Remarks.

In ligaturing an artery in its continuity : (1) Define the anatomical landmarks and the line of the artery. (2) Make the incision. (3) Expose sheath. (4) Pick sheath up with dissecting forceps. (5) Hold scalpel by the violin-bow method with the blade parallel to the sheath (Fig. 3) and make a small nick in it just enough to pass the aneurysm needle and the ligature conveniently. (6) Pass the unthreaded needle from the side of the artery which has important structures close to it, towards the opposite (less dangerous) side, thus avoid injuring these structures or including contiguous structures in the ligature. (7) Thread the needle and bring it back. (8) Tie a reef or surgical knot (and in doing so, pass the tips of your forefingers down to the vessel) tight enough to obliterate its lumen but not tighter. (9) Do not pull the artery from its bed. (10) Do not jerk. (11) Do not use force but pull steady, the ligature will not snap then. (12) Do not use ligature too thin, it might cut through the coats of the artery.

ARTERIES OF THE UPPER EXTREMITY.

Surgical Anatomy.

The Subclavian—Arises on the right side from the innominate, behind the right sterno-clavicular articulation and on the left side at a slightly lower level from the arch of the aorta. It becomes axillary at the outer border of the first rib opposite the middle of the clavicle. The scalenus anticus divides the subclavian into three parts : the first part, from the origin

of the artery to the inner margin of the scalenus anticus, the second part, behind that muscle, and the third part, from the outer margin of that muscle to the outer margin of the first rib. *The Axillary* is divided into three stages : the first stage, from the outer border of the first rib to the upper border of the pectoralis minor, the second stage, behind it and the third stage, from its lower border to the lower border of the teres major. *The Brachial* extends from the lower border of teres major to a little below the middle of the bend of the elbow. The ulnar and the radial, the terminal branches of the brachial, commence at the inner side of the neck of the radius. *The Ulnar* artery ends by passing over the anterior annular ligament at the wrist to form with a branch of the radial, the superficial palmar arch. *The Radial* artery terminates by passing backwards over the radius above its styloid process to reach the dorsal surface of the hand ; it then passes between the two heads of the first dorsal interosseus muscle to enter into the formation of the deep palmar arch. (Fig. 13.)

Indications for ligation.—The following are the main indications for ligaturing the arteries of the upper extremity :— (1) Hæmorrhage from a ruptured artery (due to fractures, dislocations or wounds). (2) Secondary hæmorrhage. (3) Aneurysm. (4) Preliminary to amputations, etc. (5) In vascular sarcomata, to check its growth and arrest hæmorrhage.

LIGATION OF THE SUBCLAVIAN ARTERY

(In its third part).

Position.—Dorsal position on the edge of the table. Raise thorax, turn head on opposite side, depress shoulder by pulling arm down along the side of the body. Stand facing the shoulder. An assistant stands between the head and the shoulder of the same side.

Surface Marking.—The cervical course of the subclavian artery is represented by a curved line from the sterno-clavicular

joint to the mid-point of the corresponding clavicle, the con-
vexity of the line extending upwards into the supra-clavicular
fossa for about $\frac{3}{4}''$ to $1''$ above the clavicle. The outer border
of the scalene muscle usually corresponds to the outer border
of the sterno-mastoid muscle, and consequently the third part
of the subclavian artery is represented by that part of the
curve, which lies between the outer border of the sterno-mastoid
and the mid-point of the clavicle. It is ligatured in the third
part (Fig. 13).
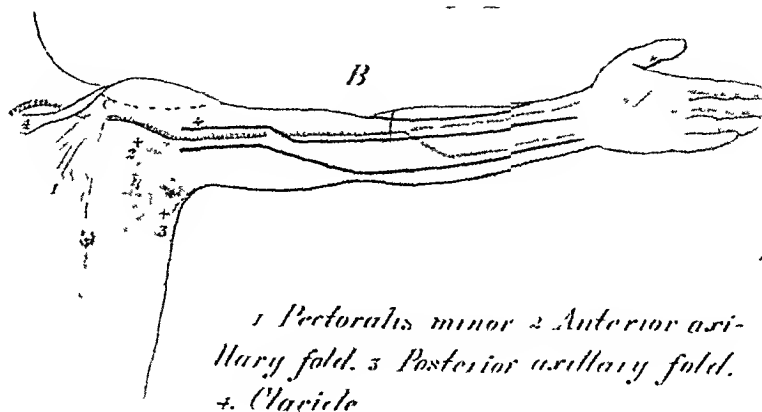
FIG. 13.
Surface marking of the arteries of upper extremity.

Operation.—Draw down the skin over the posterior
triangle of the neck with the left hand to avoid wounding the
external jugular vein. Make an incision from the outer
margin of sterno-mastoid to the inner margin of the trapezius
(base of posterior triangle), through the skin down to the
clavicle, about $3''$ long ; allow the skin to retract ; the wound
is now seen half an inch above the clavicle. This incision cuts
through integument, platysma and some supra-clavicular nerves
and exposes the deep cervical fascia. Divide this in the
whole length of the skin incision. Retract external jugular
vein or cut it between two ligatures. Define outer margin of
scalenus anticus and omo-hyoid, seek with the finger for the

scalene tubercle of the first rib and the vessel as it rests on the rib. The lowest cord of the brachial plexus is now exposed by dissection. The subclavian vein lies at the lowest part of the incision. The transverse cervical and the suprascapular arteries may or may not be seen. Pass needle from above downwards and from behind forwards, avoiding the subclavian vein below (Fig. 14).

Comment.—(1) Draw down the skin and cut down on the bone. (2) Do not prick or scrape with the knife. (3) Do not pass the needle from below, you may include the lowest brachial cord. (4) Do not injure the subclavian vein. (5) Do not injure the pleura.

Collateral Circulation.—(1) Supra-scapular from thyroid axis and posterior scapular from transversalis colli with acromio-thoracic and subscapular from axillary. (2) Superior intercostal, aortic intercostal and internal mammary with long thoracic and scapulars.

LIGATION OF THE AXILLARY ARTERY.

Surface Marking.—Take a point at the middle of the clavicle. Divide the space between anterior and posterior folds of the axilla vertically into three parts. Take a point at the junction of the upper third with lower two-thirds of this line. Join the point at the middle of the clavicle to this point. This line represents the line of the artery. This artery is ligatured in its first part or third part.

A. In the first part of the Artery.

Position.—Same as for ligation of the subclavian artery ; do not depress shoulder but let the arm lie along the side of the body.

Operation.—A curved incision with the convexity downwards is made, three inches in length about half an inch below the clavicle, in such a way that the centre of the incision is opposite the centre of the clavicle. The skin for this incision need not be pulled up or down, as there are no veins of any

PLATE III

M Omo-hyoid

M Trapezius

M Levator

Brachial Cords

M Sternomastoid

Subclavian Art
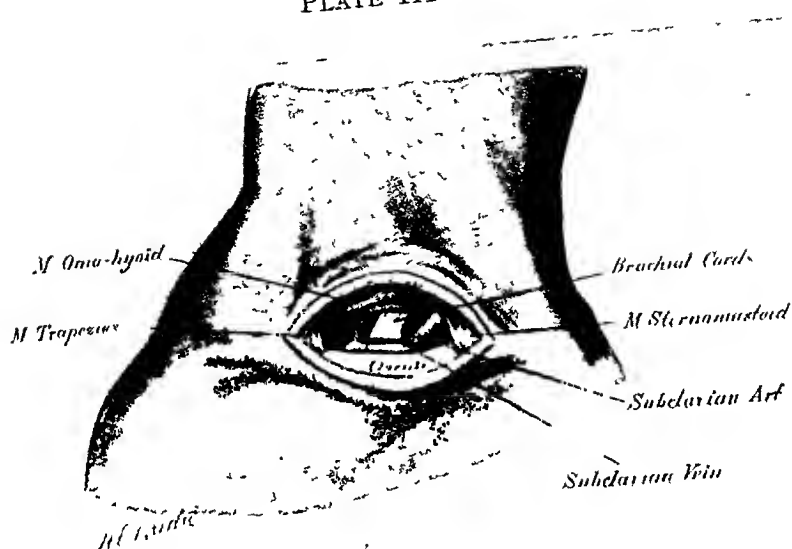
Subclavian Vein

Ligature of the Subclavian Art (Right)

Fig. 14.

To face page 12.

importance lying under the superficial structures. The skin, superficial fascia, platysma and deep fascia are divided, and the clavicular head of the pectoralis major muscle is cut for the entire length of the wound. The costo-coracoid membrane is seen and the cephalic vein noted as it comes inwards in the groove between the deltoid and the pectoralis major muscles piercing this membrane and entering the axillary vein. The cephalic vein is a good guide to the axillary artery ; the latter lies above and to the outer side of the axillary vein. The subclavius muscle may appear in the wound above, the pectoralis minor below. The axillary vein lying below and to the inner side slightly overlaps the artery. The thick axillary sheath is opened in the usual way and the aneurysm needle passed from within outwards.

Comment.—(1) Do not injure the axillary vein. (2) See that any of the cords of the brachial plexus is not caught in the ligature.

B. In the third part of the Artery.

Position.—Abduct arm at right angles to the trunk. Stand between the arm and the trunk facing the axilla. Assistant stands in front between the head and the shoulder.

Operation.—Make an incision three inches long horizontally along the line of the artery dividing integument and fascia. This exposes the inner margin of the coraco-brachialis with the musculo-cutaneous nerve entering it. Retract this outwards. Seek for the artery which is surrounded by large branches of the brachial plexus. The median nerve lying in front and to the outer side is included in the retractor for the coraco-brachialis. The musculo-spiral is behind the artery. The ulnar nerve and the veins are on the inner side. Pass the needle from within outwards (Fig. 15).

Comment.—(1) The coraco-brachialis is the guide on its inner side. (2) Do not include any of the nerves or veins surrounding the artery in the ligature. (3) An aberrant slip

from the latissimus dorsi may be passing across the vessels to join the pectoralis major or biceps, this should not be mistaken for coraco-brachialis muscle.

Collateral Circulation.—Superior profunda with subscapular, anterior circumflex and posterior circumflex.

LIGATION OF THE BRACHIAL ARTERY.

This artery is ligatured in the middle of the arm or at the bend of the elbow.

Surface Marking.—Place the arm and the forearm in the position as for axillary artery. Take the point where the axillary artery ends. Take another point at the mid-point at the front of the bend of the elbow at a level of the head of the radius. The line joining these two points is the line of the artery. The last point represents its bifurcation into radial and ulnar arteries.

A. In the middle of the Arm.

Position.—Abduct arm to a right angle and supinate forearm. Stand between the limb and the trunk. Place assistant opposite, on the other side of the arm. The arm rests on a small block placed under the olecranon. The middle of the upper arm should be free from any pressure from underneath to avoid pushing triceps forwards.

Operation.—Make an incision two and a half inches in length along the inner edge of the biceps in the line of artery. The thin fascia is divided. Identify the inner margin of the biceps carefully. Dissect gently and expose the median nerve lying in front of the artery. Retract the nerve outwards, separate venæ comites, pass aneurysm needle according to choice avoiding veins and nerves (Fig. 15).

Comment.—(1) Do not rest the upper arm on the block, the triceps may be pushed up and mistaken for the biceps. (2) The median nerve though usually in front may pass behind the artery. (3) An abnormal high bifurcation of the brachial into ulnar and radial is not unusual. (4) The artery may be

PLATE IV.

FIG. 15.

Ligature of the Axillary and Brachial Arteries.
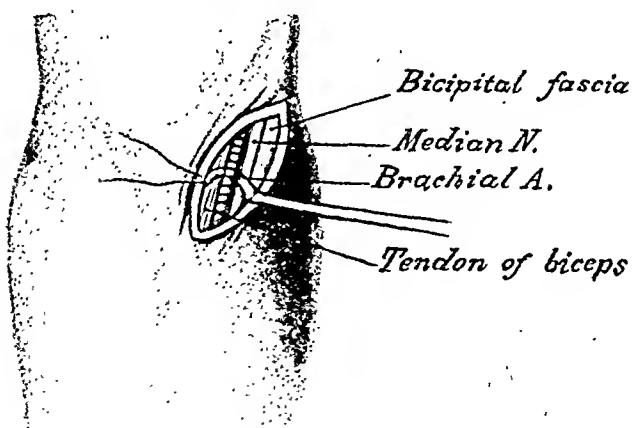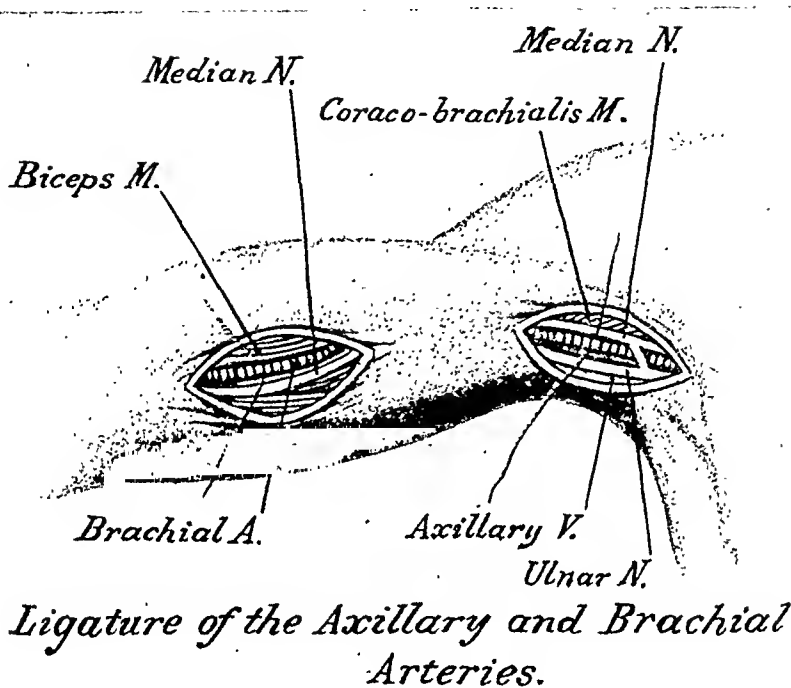
FIG. 16.

retracted with the retractor for the biceps. (5) The basilic vein, the median nerve and the inferior profunda artery have sometimes been mistaken for the brachial artery.

B. At the bend of the Elbow (Cubital Fossa).

Position.—Same as for the previous operation. Flex and extend the elbow joint to determine the exact position of the biceps tendon and leave it in a slightly flexed position for the operation.

Operation.—Make an incision two inches long through the skin and deep fascia along the inner edge of the biceps, the centre being on the crease of the elbow and its lower end pointing towards the thumb. Retract the superficial nerves and veins. The bicipital fascia is now exposed with its fibres directed obliquely downwards and inwards. Divide the fascia in the line of skin incision, *i.e.*, against the direction of its fibres. This exposes the artery with its venæ comites. The artery may be embedded in fat and freely movable. The median nerve may be seen on the inner side, at the upper part of the incision. The ulnar nerve does not come into view. Pass the needle from the inner side avoiding the median nerve (Fig. 16).

LIGATION OF THE RADIAL ARTERY.

Position.—Arm abducted at right angles and forearm supinated. Operator stands on the outer side of the arm.

Surface Marking.—Draw a line from the middle of the anticubital fossa at a level of the head of the radius to its styloid process outside the scaphoid tuberosity (Fig. 13). It can be ligatured in four situations.

A. In the upper third of the Forearm.

Operation.—Make an incision two and a half inches long in the line of the artery, dividing the skin, superficial and deep fasciæ. This exposes the interval between the longitudinal fibres of brachio-radialis (supinator longus) and oblique fibres of

pronator radii teres muscles. The artery will be found under cover of the brachio-radialis muscle. The needle can be passed from either side as the nerve is not in relation with it.

B. In the middle third of the Forearm.

Operation.—Divide skin and superficial tissues in the line of the artery. This exposes brachio-radialis (supinator longus). Define its inner border. Retract it outwards. The artery is found lying on the insertion of pronator radii teres. Separate venæ comites. Pass needle from the radial side as the nerve lies on this side.

C. In the lower third of the Forearm.

Operation.—Make an incision one and a half inches long in the line of the artery between the tendons of brachio-radialis and flexor carpi radialis. Divide the thin fascia. The artery is exposed with the radial vein lying in front of it. The venæ comites are firmly attached to it. Separate them if possible. Pass needle according to choice (Fig. 17).

D. At the back of the Wrist (in the Tabatiere Anatomique).

Position.—Hand rests on its ulnar border, the thumb extended and abducted, and the fingers extended by the assistant.

Surface Marking.—Draw a line from the tip of the styloid process of the radius to the upper angle of the first interosseus space. This indicates the line of the artery.

Operation.—Make an incision one inch long in the centre of the space between the extensor ossis metacarpi pollicis and extensor brevis pollicis. This incision crosses the line of the artery almost at right angles and when deepened exposes the artery. Pass needle from either side.

Comment.—(1) Deepen incision cautiously as the artery is liable to be cut across. (2) Do not open the tendon sheaths.

LIGATION OF THE ULNAR ARTERY.

Position.—As for the radial artery.

Surface Marking.—Take a point (*a*) at the tip of the internal condyle of the humerus and another (*b*) at the outer side of the pisiform bone. Join these points by a line and divide it into three parts. Take a third point (*c*) at the junction of the upper third with the lower two-thirds of this line (*a*, *b*). Take a fourth point (*d*) at the middle point of the elbow, at a level of the head of the radius. Join the three points (*d*, *c*, *b*). This represents the line of the artery (Fig. 13). This artery can be ligatured in the middle or the lower third of the forearm.

A. In the middle of the Forearm.

Operation.—Make an incision three inches in length along the line of the artery exposing the thin deep fascia. Incise the fascia a little to the outer side of the skin incision. This exposes the white intermuscular line between flexor carpi ulnaris and flexor sublimis digitorum. Now, flex the wrist to relax the muscles. Retract flexor carpi ulnaris inwards, flexor sublimis digitorum outwards. The ulnar nerve is exposed. The artery is on the outer side of the nerve. Pass the needle from within avoiding the nerve.

B. In the lower third of the Forearm.

Operation.—Make a two inches long incision along the line of the artery just to the radial side of the flexor carpi ulnaris tendon, the lower end of the incision ending above the pisiform bone. Divide the deep fascia. Expose and define the flexor carpi ulnaris. Flex the wrist relaxing the tendon and retract it inwards. The artery is attached to the flexor profundus by a fascia. Divide it carefully. The ulnar nerve is close to its inner side. Pass the needle from the ulnar side avoiding the nerve (Fig. 18).

Collateral Circulation.—After ligature of radial and ulnar. Anterior and posterior interosseii with anterior carpal,

PLATE V.

M J'Xcor Corpu
Rail

Radial N

M Sup Long *
Brachia radialis

AL Flex carp uln

Ulnar N

FIG. 17.

Ulnar Art

Flex Subl Dig

FIG. 18.
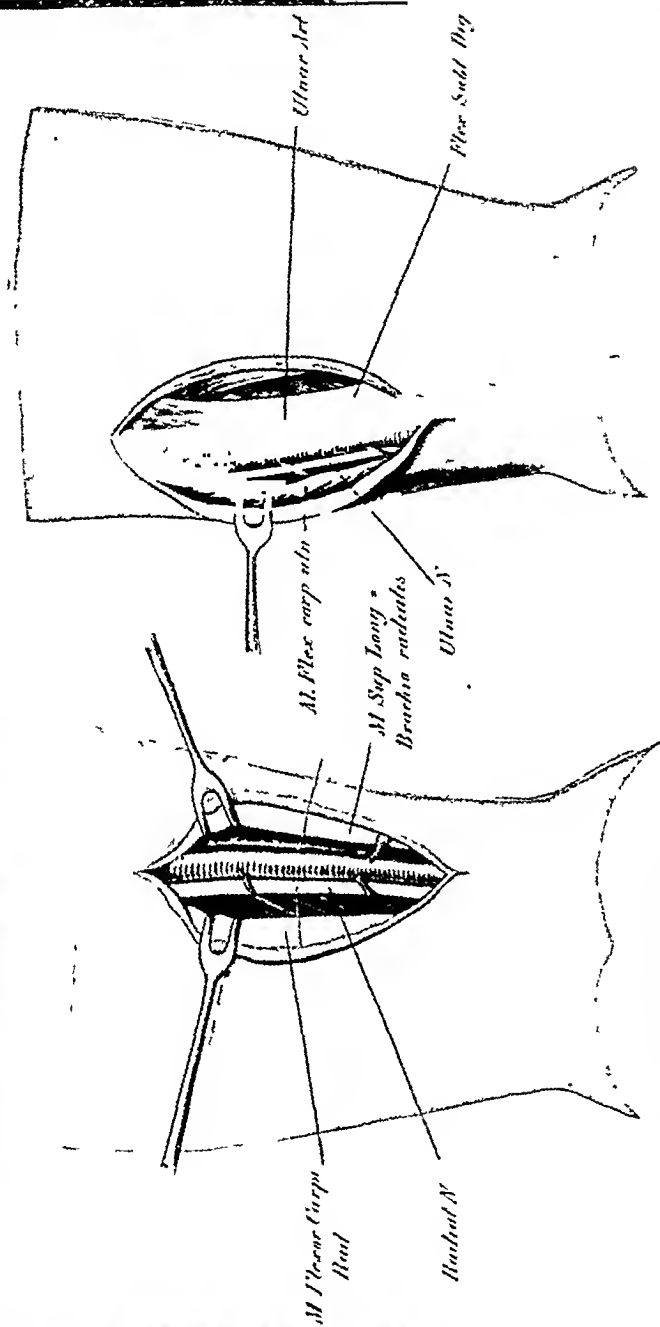
Ligature of left radial artery in the middle third of the forearm.

Ligature of the left ulnar artery (middle of the forearm).

posterior carpal and recurrent branch of the deep palmar arch.

Comment.—(1) Do not cut too deep. (2) Flex and extend, pronate and supinate to determine the various muscles. (3) The direction of the fibres of the brachio-radialis and pronator radii teres are vertical and oblique respectively. (4) The flexor carpi ulnaris is tendinous at its insertion on its outer side, but has muscular fibres attached on its inner side. (5) Position of the operator and assistant may be varied according to convenience. (6) For hæmorrhage from the ulnar or radial, proximal and distal ligatures should be applied in consideration of the free anastomotic circulation through the palmar arch.

ARTERIES OF THE HEAD AND NECK.

LIGATION OF THE MIDDLE MENINGEAL ARTERY.

Indications.—The middle meningeal artery is ligatured in cases of hæmorrhage from this vessel giving rise to symptoms of compression of the brain.

Surgical Anatomy.—The middle meningeal artery is a branch of the internal maxillary. It enters the skull through the foramen spinosum, and lies in a groove in the temporal bone. It takes a variable course in the middle fossa of the skull and at a point just above the centre of the zygoma, bifurcates into anterior and posterior branches. The anterior branch is larger and is more liable to injury since (*a*) its cranial protection of the temporal bone in this region is very thin and (*b*) it is strongly adherent to the dura, so that any impact on the skull which tends to separate this membrane from the skull tends to rupture the vessel.

Position.—The head is turned to the opposite side. The operator stands on the side he is going to trephine. The assistant stands exactly opposite to him.

Surface Marking.—(Fig. 19).

The anterior branch—Draw a line horizontally backwards from the external angular process of the frontal bone ; mark off points one, one-half and two inches on that line behind that process.   Drop lines at right angles to the above line from the above three points on to the zygoma and measure these vertical lines ; at the first point the artery lies an inch, the second point an inch and a half and at the third point two inches
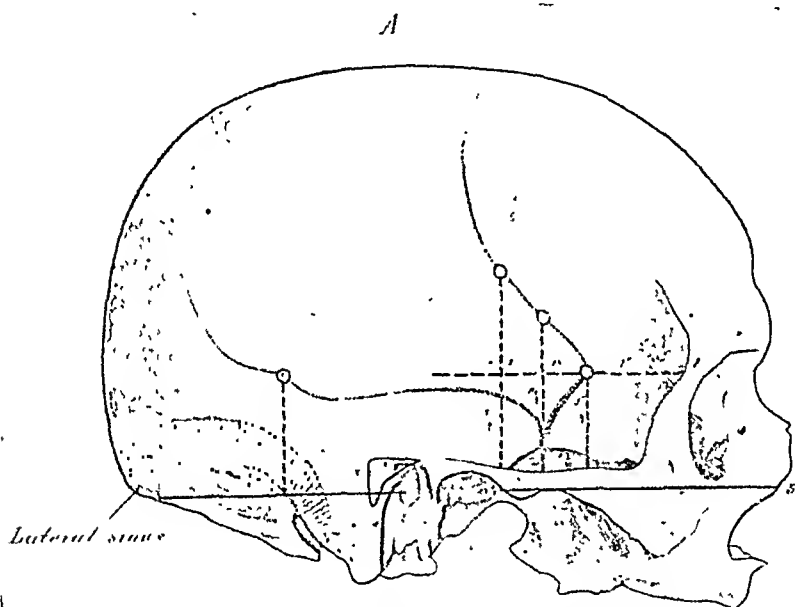
1. External angular frontal process. 2. Supra-meatal triangle. 3. Mastoid antrum. 4. Facial nerve. 5. Reid's base line.

FIG. 19.
Surface marking of the middle meningeal artery.

above the zygoma.   Join the upper terminations of these vertical lines.   This will form an oblique line representing the anterior branch of the middle meningeal artery.

The posterior branch—May be reached by placing the trephine just below and in front of the parietal eminence, one and a half inch above the external auditory meatus.

·.· *The main trunk*—May be secured by working a little lower, *i.e.*, nearer the zygoma.

Instruments.—Group VIII.

Operation.—Take any of the three points in the oblique line. Put the trephine pin on the point, drive it through the scalp on to the skull, making a superficial impression on the bone. A semi-circular incision is made scalp deep with the convexity upwards. The scalp is reflected. Now the choice lies between a muscle-flap operation or a split-muscle operation. The latter has distinct advantages. The temporal muscle is· split down to the pericranium on a line with the puncture made by the trephine pin. Along the edges of the split the muscle is reflected from the skull and retracted outwards and inwards. The impression on the bone is now seen. A trephine, an inch or three-quarters of an inch in diameter is applied. After the circular impression on the bone is made deep enough, the pin is withdrawn and trephine impression is deepened by steady and cautious circular movement till the dura is reached. The bone dust is removed and sawing is stopped as the dura mater is reached. The circular piece of bone is now removed. The artery is seen lying on the dura mater with its venæ comites. It is separated from the dura, and the aneurysm needle passed so as to include the two veins with the artery. In some cases it will be found necessary to pass a fully curved threaded needle through the dura mater under the artery. The split fibres of the temporal muscle are allowed to come together and close the trephine hole and the scalp flap allowed to return.

Comment.—While using the trephine avoid injuring the dura, brain or the artery by manipulating this instrument and the elevator cautiously.

LIGATION OF THE COMMON CAROTID ARTERY.

Indications.—The common carotid is ligatured : (1) in cases of aneurysm of the innominate, the internal carotid and the cerebral arteries ; (2) to control hæmorrhage from the face

and neck , (3) for pulsating and idiopathic exophthalmcs ; (4) as a preliminary measure to removal of tumours ; (5) eiephantiasis of the face ; (6) for epilepsy.

Position.—Dorsal position near the edge of the table ; raise shoulder, turn head on opposite side. The operator stands on the side of operation and the assistant opposite to him.

Surface Marking.—Take three points, (*a*) angle of the jaw (*b*) tip of the mastoid process (*c*) sterno-clavicular articulation. Join (*a*) and (*b*) and take its middle point (*d*) Join (*c*) and (*d*), this line marks the line of the artery. The seat of election for the ligature of the artery is above the point where the anterior belly of omo-hyoid crosses it. Here the artery is more superficially placed and less surrounded by complicated structures.

A. At the site of election.—(Above the omo-hyoid.)

Operation.—Determine the position of the cricoid cartilage, make an incision two inches long dividing the skin and the platysma in the line of the artery keeping its centre on a level of this. This exposes the deep fascia. Divide it along the anterior margin of the sterno-mastoid. Define the edge of the muscle and follow it till the omo-hyoid muscle is felt. Demonstrate the angle of the meeting of these two muscles. Retract the sterno-mastoid outwards and the omo-hyoid downwards. Feel for the pulsation of artery as it crosses the prominence of the carotid tubercle. The sterno-mastoid vessels, middle thyroid vein and the sheath of the artery are thus exposed. Open the sheath on the inner side avoiding the descendens noni nerve lying on it and the internal jugular vein ·lying on the outer side. Separate the sheath from the artery with great care and pass the needle from without inwards keeping close to the coat of the artery.

Collateral Circulation.—(1) Superior thyroid, lingual, facial, and occipital with corresponding vessels of the

opposite side. (2) Superior thyroid and inferior thyroid. (3) Vertebral with the vertebral of the opposite side. (4) Princeps cervicis of occipital and deep cervical branch of the superior intercostal.

Comment.—(1) Do not turn the head too far to the opposite side, this may lead to the overlapping of the vessels by the sterno-mastoid. (2) The anterior jugular vein may have to be divided between two ligatures. The small sterno-mastoid artery and other small veins may be found to cross the artery. (3) Open the sheath well on the inner side, because the internal jugular vein is on the outer side and may even be overlapping the artery. The needle must be passed with great care, closely in contact with the vessel and passing directly between it and the sheath, and by this you will avoid transfixing the artery and including descendens noni, the pneumogastric, recurrent laryngeal or even the sympathetic in the ligature.

B. Below the omo-hyoid.

Operation.—Incision about three inches long in the line of the artery, commencing a little below the cricoid and extending to the sterno-clavicular articulation. The steps of the operation are the same as in the previous operation, but omo-hyoid is drawn upwards and the sterno-thyroid and sterno-hyoid inwards. The sheath is opened on the inner side and the needle is passed from without inwards.

Comment.—(1) The vessel lies deeply in the neck and renders the operation dangerous and difficult. (2) The inferior thyroid and the internal jugular veins may obscure the view of the artery. (3) Other points of comment apply to this as to the previous operation. (4) In some cases of ligature of the common carotid, hemiplegia may follow due to extension of thrombus from the site of ligature along internal carotid to the cerebral arteries, an attenuated form of infection being a probable factor.

LIGATION OF THE EXTERNAL CAROTID ARTERY.

Position.—The same as in the previous operation.

Surgical Anatomy.—The common carotid artery divides at the level of the upper border of the thyroid cartilage into the internal and external carotids. The external carotid about an inch from its origin lies very superficially being only covered by skin and fascia, and overlapped by the sterno-mastoid muscle. It terminates behind the condyle of the jaw by dividing into superficial, temporal and internal maxillary arteries. From below upwards, the following branches are given off: ascending pharyngeal, superior thyroid, lingual (opposite the greater cornu of the hyoid bone), facial, and occipital; the hypoglossal nerve crosses the external carotid artery an inch above its origin.

Surface Marking.—(1) A direct prolongation upwards of the common carotid line. (2) Draw a line from the tip of the lobule of the ear to the greater cornu of the hyoid bone.

At the site of election.—*i.e.*, between the superior thyroid and lingual branches of the artery.

Operation.—Incision about three inches long, in the line of the artery commencing on a level with the middle of the thyroid cartilage and terminating near the angle of the jaw; the centre of the incision will correspond to the greater cornu of the hyoid bone and it divides the skin and platysma only. Expose the anterior border of the sterno-mastoid in the lower part of the wound. Retract it outwards, search for the posterior belly of the digastric at the upper angle of the wound. Below this the hypoglossal nerve is seen. Expose the artery opposite the level of the tip of the great cornu. Pass the needle from without inwards, avoiding the facial and superior thyroid veins (Fig. 20).

Comment.—(1) There are large veins running over and in relation to this vessel. (2) The hypoglossal nerve is often a good guide. (3) The artery has complicated relations with

PLATE VI.

Great auricular
Nerve

Int Jugular L

Spinal accessory N

Sternomastoid M

Descendens hyp glossi N

Hypoglosal N.

Int laryngeal N

Sup thyroid art
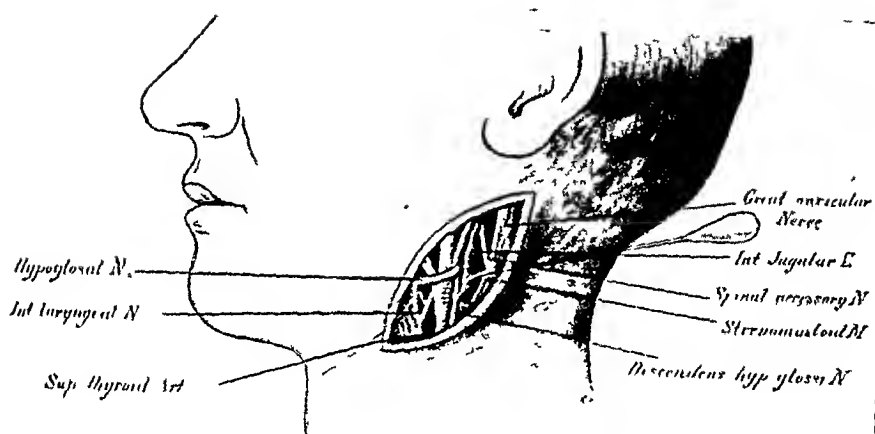
Ligature of the External Caroted Art. (Left)

FIG. 20.

To face page 24.

important structures. It must be identified from the internal carotid which has no branches in the neck and from its own numerous branches. (4) The branches of the internal carotid of either side anastomose so freely that the ligation of one vessel does not materially affect the hæmorrhage in the regions supplied by these vessels.

Collateral Circulation.—The circulation is re-established by the free communication between (*a*) most of the large branches of the artery (facial, lingual, superior thyroid, occipital) and the corresponding arteries of the opposite side ; (*b*) by the anastomosis of its branches with those of the internal carotid ; (*c*) of the occipital with branches of the subclavian.

LIGATION OF THE LINGUAL ARTERY.

Indications.—(1) Preliminary to excision of the tongue. (2) In cases of inoperable cancer of the tongue to check the rate of its growth and to restrain hæmorrhage. (3) In cases of hæmorrhage due to wounds of the vessel. (4) In cases of macroglossia.

Surgical Anatomy.—The lingual artery arises from the external carotid opposite the greater cornu of the hyoid bone. It first ascends to a point a little above the level of the hyoid bone ; here it is covered by the skin, platysma, fasciæ and some veins, and it lies upon the middle constrictor of the pharynx. It then descends and runs just above the greater cornu still lying upon the middle constrictor and is covered by hyoglossus and mylo-hyoid muscles. The hypoglossal nerve and the lingual vein is separated from it by the hyoglossus muscle. Finally it emerges from under the hyoglossus muscle and runs to the under surface of the tongue with a tortuous course as ranine artery being covered only by its mucous membrane.

A. At its origin.—Incision as for ligature of the external carotid artery and the operation corresponds to its ligation at the site of election. Pass the ligature from without inwards.

B.   At the site of election.—i.e., beneath the hyoglossus.

Position.—Patient is close to the edge of the table in dorsal position with the shoulder raised and face turned to the opposite side.   The operator stands on the side of operation. One assistant keeps the chin drawn well upwards and the lower jaw fixed.   A second assistant stands by the side of the operator to retract the digastric tendon.

Operation.—Commence the incision from a little below and external to the symphisis menti curving down to a point near the cornu of the hyoid bone, and then curving upwards to terminate below and in front of the angle of the mandible. Divide the skin, superficial fascia, platysma, and then the deep fascia.   The submaxillary gland which is now exposed is separated from its deep attachments and retracted upwards on to the face.   This exposes the digastric triangle with the anterior belly of the digastric and the mylo-hyoid muscle in front, the posterior belly of the digastric behind, the floor being formed by the hyoglossus muscle.   Running across the floor on the muscle are the hypoglossal nerve above and the ranine vein below ; displace these two structures upwards and pull the digastric tendon downwards with a blunt hook.   Make a small transverse incision on the hyoglossus muscle (across its fibres) below and parallel to the ranine vein.   The artery will come into view as soon as the whole thickness of the muscle is divided.   The needle is passed from above downwards (Fig. 21).

Comment.—(1) Ligaturing this artery presents certain difficulties :—(*a*) The soft structures may be matted together due to old cellulitis, (*b*) there may be large veins, *e.g.*, lingual and facial, (*c*) in old people the artery may lie at a considerable depth in the wound, (*d*) there may be enlarged lymphatic glands and the submaxillary salivary gland may be unusually large.   (2) The hypoglossal nerve is a surer and better guide than the ranine vein due to its variation in position and condition. · (3) The hyoglossus muscle is to be divided by repeated light touches of the scalpel to avoid injury to the

PLATE VII.

Hyp. N.   R. V.
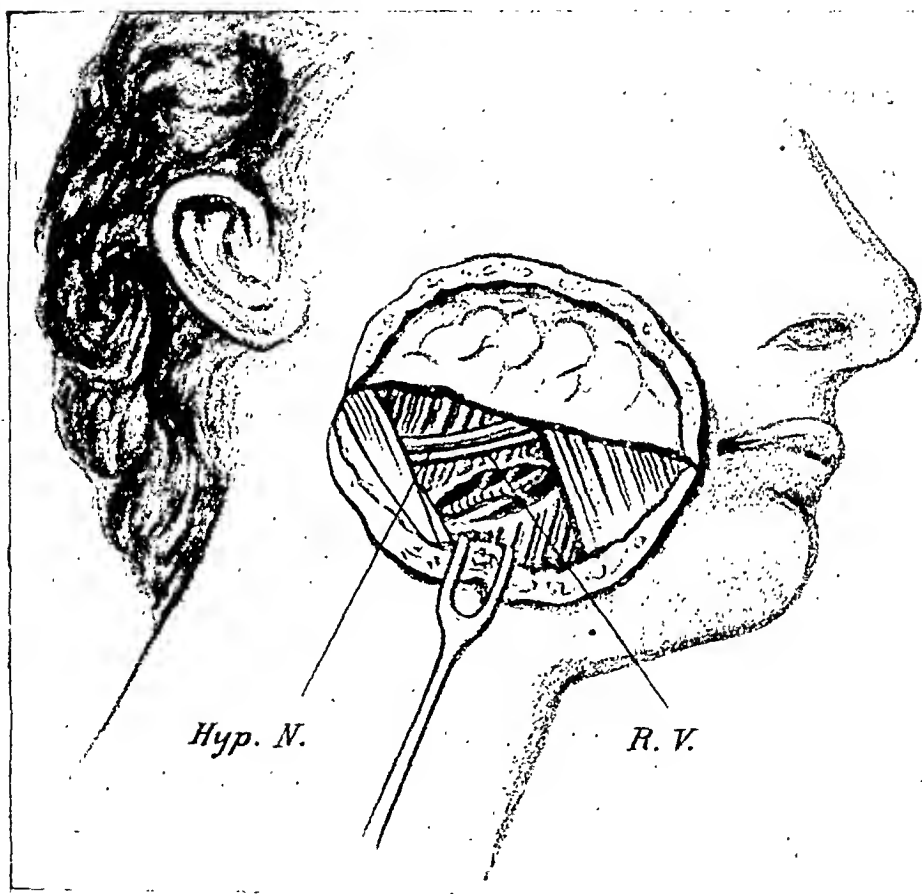
FIG. 21.
Ligation of the lingual artery.

underlying artery. (4) Fix the digastric tendon securely and pull it down effectively in order to obtain better view of the field of operation and to put the hyoglossus muscle on the stretch before division.

LIGATION OF THE FACIAL ARTERY.

Indications.—(1) Wounds of the artery. (2) Preliminary to excision of the lower jaw.

Surgical Anatomy.—The facial artery comes off the external carotid in the neck about an inch above its bifurcation, passes up to the submaxillary gland and is embedded in it, crosses the jaw at the anterior edge of the masseter and then goes to the side of the face.

Operation.—A small horizontal incision is made along the lower edge of the jaw up to the anterior edge of the masseter through the skin, fascia and platysma. The artery is at once exposed. Pass the needle from behind forwards as the facial vein lies behind the artery.

LIGATION OF THE TEMPORAL ARTERY.

Indications.—Wounds and aneurysms of the artery.

Surgical Anatomy.—The temporal artery is one of the terminal branches of the external carotid. It is given off at the bifurcation of the external carotid behind the jaw at a point midway between the condyle of the jaw and the tragus. It then passes over the root of the zygoma, ascends for about two inches and then divides into anterior and posterior branches under the covering of the dense parotid fascia.

Operation.—Make a vertical incision one inch long, in the line of the artery with the mid-point opposite the root of the zygoma, cutting through the superficial and deep fasciæ. This exposes the artery with the auriculo-temporal nerve lying in front and the temporal vein behind. Pass the needle from behind forwards.

LIGATION OF THE OCCIPITAL ARTERY.

Indications.—Wounds of the vessel (stabs, gun-shot wound, etc.) and cirsoid aneurysm of the scalp.

Surgical Anatomy.—It comes off as a posterior branch of the external carotid from a point corresponding to the branching of the facial. It makes an upward course under the cover of the digastric and stylo-hyoid muscles to the interval between the transverse process of the atlas and the mastoid process. It then turns backwards, lying at first in a groove of the temporal bone and then on the complexus being covered by the posterior cervical muscles. Then running vertically upwards and piercing the trapezius, it ascends to the scalp.

Operation.—An oblique incision two inches long extending from the tip of the mastoid process towards the external occipital protuberance, dividing the superficial structures and exposing the sterno-mastoid insertion. The artery is now found lying in the space between the mastoid process and the transverse process of the atlas under cover of the posterior belly of the digastric. Pass the needle according to convenience.

LIGATION OF THE INTERNAL CAROTID ARTERY.

Indications.—(1) Wounds of the artery. (2) Aneurysm of the internal and common carotid arteries. (3) Orbital aneurysm. (4) Traumatic exophthalmos.

Surface Marking.—Practically the same as that for common carotid.

Operation—Is much the same as that for ligation of the external carotid.

LIGATION OF THE VERTEBRAL ARTERY.

Indications.—(1) Wounds . (2) Traumatic aneurysm. (3) In epilepsy with the object of reducing the blood supply to the hind-brain.

Surgical Anatomy.—The vertebral is the first branch of the subclavian and the springs from its upper and back parts. It passes along the inner margin of the scalenus anticus and enters the foramina transversorium of the upper six cervical vertebræ to become the basilar artery by uniting with its fellow of the opposite side.

Position.—Same as that for ligation of the common carotid.

Operation.—Make an incision three inches long, along the lower part of the posterior border of the sterno-mastoid extending down to the clavicle and dividing the skin, superficial fascia and platysma. Now, divide the deep fascia taking care not to injure the external jugular vein which lies superficial to it. Retract the sterno-mastoid forwards and define the scalenus anticus at the carotid tubercle. Displace the carotid sheath inwards. The artery can be felt immediately below the tubercle. Pass the needle from without inwards, keeping clear of the veins.

Comment.—(1) The artery is deep in situation and there is a fair amount of venous oozing. (2) Relax the muscles of the neck in order to get as good a view as possible. (3) Contraction of the corresponding pupil on applying the ligature indicates that the vertebral has been secured.

LIGATION OF THE INTERNAL MAMMARY ARTERY.

Indications.—Hæmorrhage from the artery due to wounds (punctured, stab or gunshot, and due to fractured ribs).

Surgical Anatomy.—Coming off the first part of the subclavian, it descends along the external margin of the sternum, half an inch external to it, lying on the pleura and triangularis sterni muscle. It terminates behind the sixth costal cartilage by dividing into musculo-phrenic and superior epigastric.

Operation.—Make a transverse incision about one and half inches long from the outer margin of the sternum in an

intercostal space according to indication. Split the fibres of the pectoralis major and retract ; cut the anterior intercostal aponeurosis and the internal intercostal muscle avoiding anterior perforating vessels and nerve. The artery is now exposed. Pass the needle from without inwards.

Comment.—It is often difficult to isolate the artery. Do not injure the pleura while cutting through internal intercostal. Do not injure the artery.

CHAPTER III.

LIGATION OF ARTERIES. (CONTD.)

THE ILIAC ARTERIES.

LIGATION OF THE COMMON ILIAC ARTERY.

Indications.—(1) Aneurysm of the external iliac. (2) Wounds (gunshot, stabs, etc.), causing immediate or secondary hæmorrhages. (3) *Pulsating tumours.*

Surface Marking.—Draw a line from a point about half an inch below and half an inch to the left of the umbilicus to the centre of a line joining the anterior superior iliac spine to the symphysis pubis. Divide this line into three equal parts. The upper third represents the common iliac and the rest of it the external iliac.

Operation.—The artery can be ligatured either extraperitoneally or intraperitoneally.

Extraperitoneal method.—Make an incision six inches long, two inches above, and to the outer side of the middle of Poupart's ligament curving at first towards the anterior superior iliac spine, then directly upwards and, finally, bending slightly in the direction of the umbilicus. Subsequent stages of the operation are similar to ligation of the external iliac which, in this case, has to be traced upwards till the common iliac is found.

Intraperitoneal method.—Open the abdomen by a mesial incision four inches long. The further stage of the operation resembles that for the ligation of the external iliac by transperitoneal route.

Collateral Circulation.—(1) Internal mammary and lower intercostals with the deep epigastric. (2) Lumbar

arteries with the ilio-lumbar and circumflex iliac. (3) Middle sacral with lateral sacral. (4) Superior hæmorrhoidal with middle and inferior hæmorrhoidals.

LIGATION OF THE INTERNAL ILIAC.

Indications.—(1) Gluteal and sciatic aneurysms. (2) Hæmorrhage from punctured and other wounds. (3) Inoperable uterine tumours and pelvic sarcomata. (4) Prophylactic against hæmorrhage in pelvic operation, *e.g.*, panhysterectomy and abdomino-perineal excision of cancerous rectum. (5) To bring about atrophy of the enlarged senile prostate.

Operation.—This vessel can be ligatured intraperitoneally or extraperitoneally. The incision and preliminary parts of the operation are the same as that for the ligation of the common iliac artery. Look for the bifurcation and the external iliac branch which is comparatively superficial in situation. Identify the upper margin of the great sacrosciatic notch which corresponds with the lower end of the artery. Pass the needle from within out.

LIGATION OF THE EXTERNAL ILIAC ARTERY.

Indications.—The chief indications are—(1) Aneurysm of the upper part of the femoral. (2) Wounds of the external iliac. (3) Aneurysm of the common iliac (distal operation). (4) Elephantiasis of the lower extremity.

Surface Marking.—Same as for the common iliac. The lower two-thirds of the line represents the line of the external iliac.

Operation.—This vessel can be ligatured by extraperitoneal or transperitoneal routes.

Extraperitoneal method. (Old method).

Position.—Dorsal position. Operator stands on the side to be operated on, facing the patient. Assistant stands on the opposite side.

c, os

Two classical methods have been described—(*a*) Cooper's method by oblique incision ; (*b*) Abernethy's more vertical incision.

(*a*) **Cooper's method (modified).**—An oblique incision, three and half inches long is commenced at a point one and three-fourths of an inch external to the pubic spine and carried parallel to the Poupart's ligament half an inch above it, and then curved upwards and inwards to terminate at a point an inch above and internal to the anterior superior iliac spine. This incision cuts through the skin and subcutaneous tissues. The aponeurosis of the external oblique is divided in the entire length of the skin wound. This exposes the spermatic cord and the internal oblique muscle. Define the external border of the conjoined tendon and retract it. The lower fibres of the internal oblique are drawn upwards and divided close to their attachment to Poupart's ligament. Transversalis fascia is exposed and divided in the transverse direction, avoiding the deep epigastric artery. Remove by carefully loosening the subperitoneal tissue. The peritoneum is then peeled off the artery by gauze-covered fingers. The artery is now found lying on the inner side of the psoas. Pass the needle from within out. Close the abdominal incision by bringing together the individual muscles.

Comment.—The parietal incision somewhat corresponds to the incision for inguinal hernia. While making these incisions—(1) Avoid injury to external ring, spermatic cord and circumflex iliac vein. (2) Avoid wounding the peritoneum. (3) Avoid injury to the genito-crural nerve or its inclusion in the ligature. (4) The ilio-inguinal nerve may be exposed when dealing with the muscles, do not injure it. (5) The deep epigastric artery may be injured while dividing the transversalis fascia. (6) The artery should be ligatured at least one and three-quarter inches above Poupart's ligament, *i.e.*, at safe distance from the point from which the larger branches (deep epigastric and deep circumflex iliac) are given off.

(*b*) **Abernethy's method.**—This method differs from Cooper's in the direction and position of the incision. This is made by commencing at a point an inch above and an inch to the inner side of the anterior superior iliac spine, then curving downwards and inwards to terminate at a point an inch and a half above and slightly external to the centre of Poupart's ligament. The rest of the operation follow the same method as Cooper's.

Comparison of the two methods.—The one advantage claimed for Abernethy's operation is that the ligature is placed higher up than in the other method, and this is a matter of consideration if the operation is undertaken for aneurysm of the femoral artery. Its disadvantages are many, *viz.:* — (1) There is a greater risk of post-operative (ventral) hernia. (2) One has to work at a greater depth to secure the artery. (3) Therefore there is a greater risk of wounding the vein. The advantages claimed for Cooper's method are—(1) This operation is easier to perform. (2) There is less division of muscles. As a matter of fact the operation can be performed by splitting the muscles and not dividing across their fibres. (3) There is less disposition to ventral hernia. (4) The peritoneum in this part is not so firmly adherent to the vessel sheaths as it is higher up.

Intraperitoneal method.

Operation.—A laparatomy wound, three inches long, is made through the para-rectal route (*vide infra*). The artery is exposed and ligatured as in the above methods.

Comment.—The advantages of this operation are manifold. (1) The artery is fully and easily exposed. (2) Important pelvic structures can be better avoided. (3) It affords greater care and accuracy. (4) The danger of opening the peritoneum and its infection, which was a strong point in favour of extra-peritoneal methods in pre-antiseptic days, can now be disregarded.

Collateral Circulation.—(1) Deep epigastric with internal mammary, lower intercostals and lumbar. (2) Deep

circumflex iliac with ilio-lumbar, lumbar and gluteal. (3) Gluteal and sciatic with internal and external circumflex. (4) Obturator with circumflex and epigastric. (5) Internal pudic with external pudic.

ARTERIES OF THE LOWER EXTREMITY.

THE FEMORAL ARTERY.

Surgical Anatomy.—It is a continuation of the external iliac and extends from the lower border of Poupart's ligament to the tendinous opening in the adductor magnus at the junction of the upper two-thirds with the lower third of the femur. In its course the first one and a half inch of the vessel is called the common femoral and the rest is termed the superficial femoral (the femoral artery), while the deep femoral is a large branch given off by the common femoral at its termination. In the upper half of its course the artery lies in Scarpa's triangle (the femoral trigone), which is a triangular space bounded by Poupart's ligament above, the inner margin of the sartorius externally and the inner margin of the adductor longus internally, the floor being formed by the psoas, iliacus, pectineus and adductor longus muscles. The base of the triangle is formed by the Poupart's ligament and the apex at the point where the sartorius and adductor longus muscles meet. In the lower half of its course it lies deeply in Hunter's canal (adductor canal). This is an aponeurotic sheath or tunnel in the middle third of the thigh extending from the apex of the Scarpa's triangle to the femoral opening in the adductor magnus. It has the vastus internus on its outer side, adductors longus and magnus behind and the roof is formed by an aponeurotic sheath extending from the vastus internus to adductors longus and magnus on which lies the sartorius muscle.

The femoral vein lies on the inner side of the artery in Scarpa's triangle and at its apex it goes behind the artery. It crosses the artery from behind in its passage through Hunter's canal and gets to its outer side at the lower part of the canal.

Surface Marking.—Take the mid-point between the anterior superior iliac spine and the symphisis pubis and join it to the most prominent part of the internal condyle (adductor tubercle). Upper one-half of this line represents the common femoral and the rest the superficial femoral. Upper third of this line represents the artery in Scarpa's triangle ; middle-third represents it in Hunter's canal and, from the lower-third, it becomes the popliteal artery (Fig. 22).

1.— Adductor longus muscle.
2.— Sartorius muscle
3.— Anterior crural nerve.
4.— Common femoral artery.
5.— Internal or long saphenous vein.
6.— Adductor tubercle.
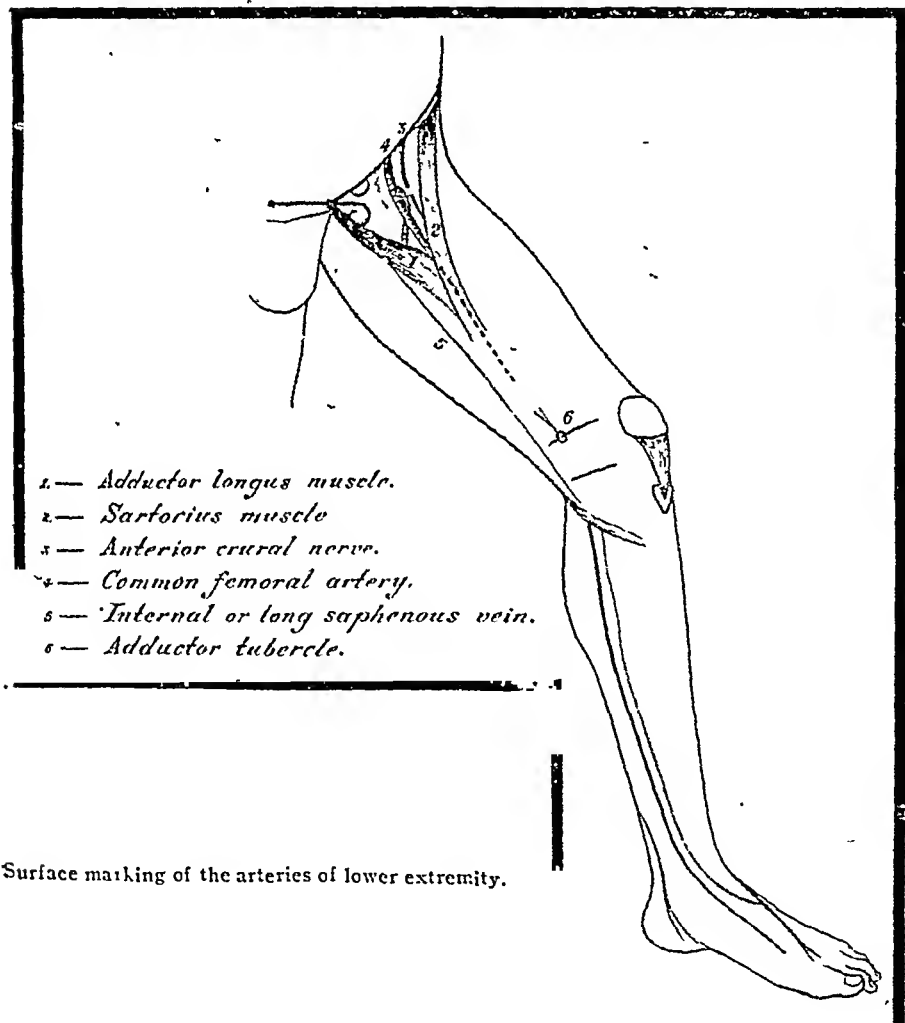
Surface marking of the arteries of lower extremity.

Fig. 22.

LIGATION OF THE COMMON FEMORAL

(At the base of Scarpa's triangle).

Indications.—'1) Wounds. (2) Removal of growths from the Scarpa's triangle. (3) Erosion of the artery by new growths or septic processes. (4) Aneurysms of the superficial femoral and popliteal. (5) Aneurysmal varix of the groin. (6) As a preliminary measure to amputation at the hip-joint.

Position.—Flex hip slightly, abduct and rotate the thigh outwards and flex the knee ; the leg rests on external surface. Operator stands on outer side of the limb and the assistant opposite to him.

Operation.—Skin incision two inches long, commencing a little above Poupart's ligament in the line of the artery. Divide a layer of fatty tissue covering fascia lata, avoiding superficial veins and lymphatic glands. Divide the cribriform fascia. Avoid external pudic and superficial epigastric arteries. The femoral sheath is exposed, the artery will be found in the outermost of the three compartments. Expose the sheath clearly. The crural branch of the genito-crural nerve lies upon the sheath on its outer side. The vein lies in the middle compartment and the crural canal in the innermost. Open the sheath carefully on the outer side, avoiding the genito-crural nerve. Pass the needle from the inner side, *i.e.*, from the side of the vein (Fig. 23).

Comment.—(1) The middle of Poupart's ligament is outside the line of the vessel and does not correspond with the mid-point between symphysis pubis and anterior superior iliac spine. (2) The vein lying in the middle compartment is not likely to be injured, but do not wound any of the superficial veins or arteries as they are needed for collateral circulation. (3) Cut the sheath slightly on the outer side so as to avoid the genito-crural nerve, which must not be included in the ligature.

Collateral Circulation.—(1) Superficial circumflex iliac with external circumflex. (2) Gluteal and sciatic with circumflex and superior perforating. (3) Comes nervi ischiadici
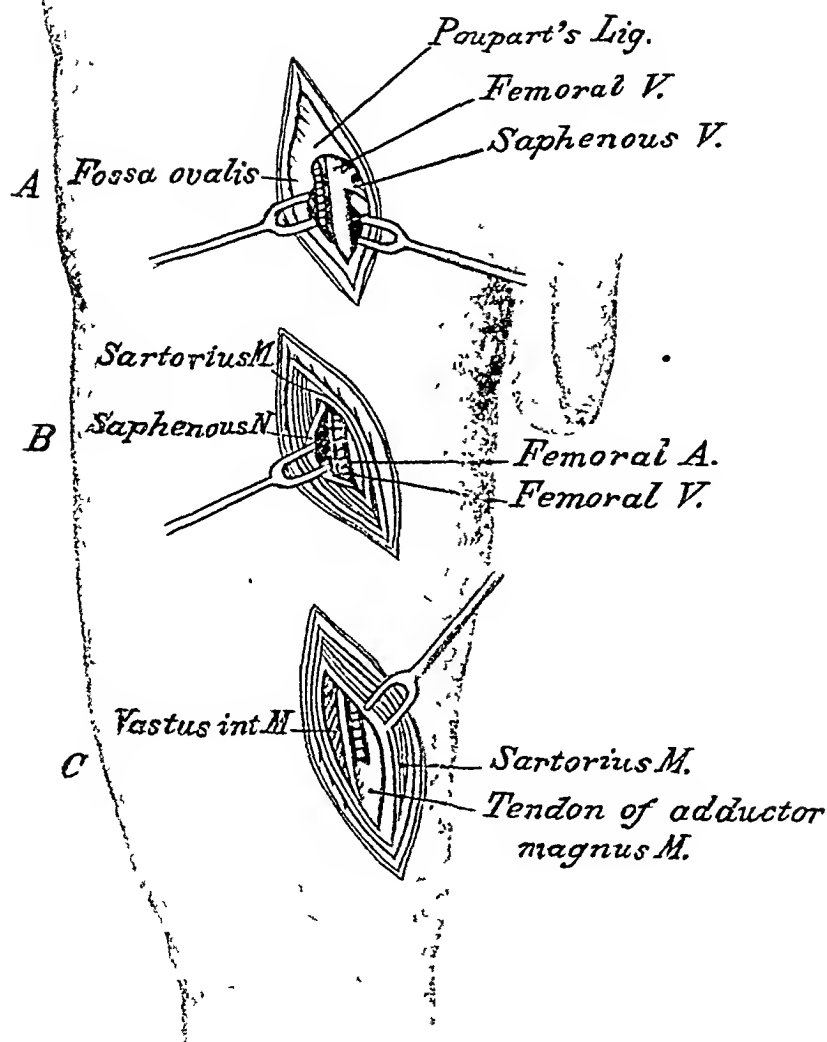
PLATE VIII.

FIG. 23—A. FIG. 24—B, FIG. 25—C.
Ligation of the femoral artery.

with perforating of profunda and articular of popliteal. (4) Obturator with internal circumflex.

LIGATION OF THE SUPERFICIAL FEMORAL.

A. At the apex of Scarpa's triangle—*i.e.*, at the site of election.

Indications.—(1) Popliteal aneurysm. (2) Aneurysmal varix. (3) Wounds of the femoral artery. (4) Hæmorrhage from the femoral artery. (5) To reduce the blood supply in cases of elephantiasis of the leg and sarcomata.

Position.—As for ligation of common femoral.

Operation.—Make an incision, in the case of the right thigh, from above downwards, and, on the left, from below upwards, three inches long, in the line of the artery, the centre of the incision corresponding to the apex. The branch of the internal saphenous vein is exposed, retract it. Divide the fascia lata. The sartorius is exposed at the lower and outer part of the wound, retract it outwards. The fibres have a downward and inward direction. Now feel for the artery and its pulsation. Superficially, branches of the internal cutaneous nerves are seen and deeper on its outer side the long saphenous nerve. Open the sheath and pass the needle from within outwards, keeping it close to the coats of the artery (Fig. 24).

Comment.—(1) Roughly speaking, the upper end of the incision could be a hand's breadth below Poupart's ligament. (2) Scarpa's triangle is smaller than is seen in a dissected specimen. (3) Sartorius is the only muscle in that region, which has its fibres running obliquely downwards and inwards. (4) Do not wound internal saphenous vein, which is rather superficial. (5) Remember that the femoral vein lying behind the artery, may be injured while passing the needle.

Collateral Circulation.—(1) External circumflex and perforating branches of the profunda (deep femoral) with branches of popliteal and anterior tibial recurrent. (2) Comes nervi ischiadici with perforating branches of the profunda (deep femoral) and branches of the popliteal.

B. In Hunter's canal.

Indications.—(1) Hæmorrhage from the stump after amputation in the lower-third of thigh or knee. (2) Wounds incised punctured, etc.

Position.—As for the previous operation.

Operation.—Make an incision, three inches long, in the line of the artery in the middle part of the thigh. The internal cutaneous nerve and the long saphenous vein may be seen in the subcutaneous tissue. Retract them inwards. Divide fascia lata exposing the sartorius, identifying it by the direction of its fibres running downwards and inwards. Retract it by its outer edge inwards. The roof of Hunter's canal is now exposed, formed by a fascia, with its fibres running transversely from the vastus internus to adductors magnus and longus. Make an incision in the roof in the line of the original wound. This opens Hunter's canal and exposes the artery. The vein lies behind and partly to the outer side. Pass needle from either side (Fig. 25).

Comment.—(1) Keep rigidly in the line of the artery and in the middle-third of the thigh in making the incision, for (a) if the incision is made too far outwards, the vastus externus is exposed instead of the sartorius. The vastus fibres run downwards and outwards, the sartorius fibres downwards and inwards ; (b) if it is made lower than the middle-third, the vessel is exposed below the opening in the adductor magnus after it has become the popliteal. (2) Avoid the vein and internal saphenous nerve. (3) The site of the canal is best demonstrated by fully abducting the thigh which makes the fibres of adductors magnus and longus prominent.

LIGATION OF THE POPLITEAL ARTERY.

Indications.—(1) Injury to the popliteal artery (e.g., due to dislocation, fracture, punctured and crushed wounds, or during osteotomy). (2) Aneurysm of the lower part of the popliteal. (3) Wounds of the leg with hæmorrhage of uncertain origin (e.g., from anterior or posterior tibial).

Surgical Anatomy.—This vessel commences at the opening in the adductor magnus near the junction of the upper two-thirds with the lower-third of the femur on its inner aspect. The vessel at first passes obliquely downwards and outwards to the mid-point of the popliteal space and then vertically downwards to the lower border of the popliteus muscle. Here it terminates by dividing into anterior and posterior tibial arteries. The point of bifurcation corresponds with the tubercle of the tibia. It can be tied best at its commencement on the inner side of the thigh, where it is found between the tendons of semi-membranosus and adductor magnus.

A. In its upper part—(*i.e.*, on the inner side of the thigh.)

Position.—Flex hip slightly. Fully abduct the thigh and rotate it outwards. Flex knee-joint at right angles. Operator stands on the outer side and bends over the limb. The assistant stands opposite.

Operation.—Incision three inches long on the right side from above downwards and on the left side, from below upwards, begins at the junction of the middle and lower-thirds of the thigh. It runs parallel with and just behind the tendon of the adductor magnus. The subcutaneous fat is exposed with a branch of the internal cutaneous nerve. Retract the nerve outwards. Define the anterior edge of the sartorius and retract it backwards. If the internal saphenous vein is exposed lying on this muscle, it is retracted with the muscle. Divide the deep fascia, seek for the adductor magnus. Draw it forwards. Expose the semi-membranosus, retract it backwards. The artery will be found in the interval between the semi-membranosus and the adductor magnus surrounded by much connective tissue and lying close to the bone. The internal popliteal nerve lies on the outer side of the artery. The artery is most superficial of all these three structures. Take an aneurysm needle with a large lateral curve and pass it from below upwards (Fig. 26).

PLATE IX.

Adductor magnus M.

Semimembranosus
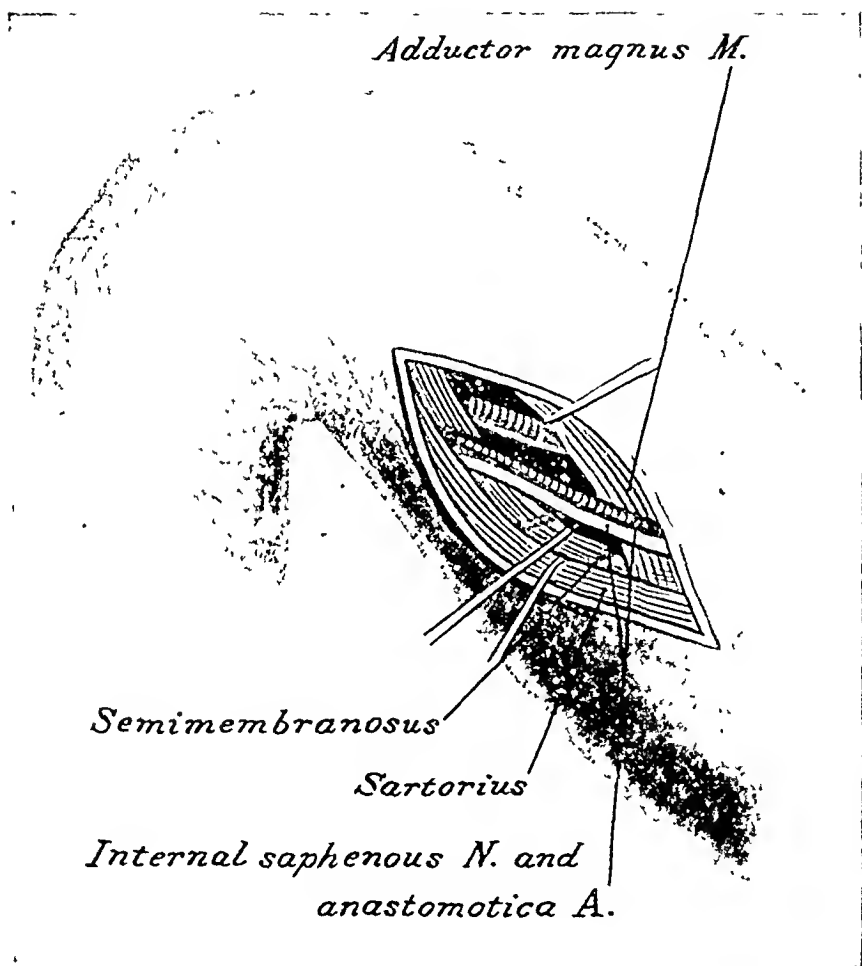
Sartorius

Internal saphenous N. and
anastomotica A.

Fig. 26.
Ligation of the popliteal artery.

Comment.—(1) This operation is the easier of the two and the one most commonly performed. (2) The internal saphenous vein is on the surface of the sartorius muscle and the deep branch of the anastomotica magna artery along the anterior surface of the adductor magnus tendon ; avoid both. (3) The tendon of the adductor magnus is a good guide to the vessel.

Collateral Circulation.—(1) Anastomotica magna, superior articular and descending branch of external circumflex with inferior articular and recurrent anterior tibial.

B. In its lower part—(*i.e.*, in the popliteal space.)

Position.—Place patient in such a prone position as would admit administration of anæsthesia. Extend leg fully. Operator stands on the outer side of the left limb and the inner side of the right. Assistant stands opposite.

Operation.—Make a vertical incision three and half inches long in the middle line of the popliteal space, commencing about the level of the knee-joint, and extending downwards over the interval of the two heads of the gastrocnemius. This divides the skin and superficial fascia and exposes the short saphenous vein and nerve. Divide the deep fascia in the same vertical line. Identify the heads of the gastrocnemius muscle and separate them widely. The following structures are now exposed : plantaris, crural arteries and the communicans tibialis nerve. Draw these to one side. The short saphenous vein is the guide to the vessel. Flex the knee-joint to relax the gastrocnemius. The following structures are now found in order from behind forwards : first the internal popliteal nerve, then the popliteal vein and then the artery. Draw the nerve and vein to the inner side, clean the artery and its sheath and pass the needle from the inner side.

Comment.—(1) Avoid injury to the vein by retracting it carefully together with the internal popliteal nerve. (2) Knee should be fully flexed to relax the muscles before passing the needle.

Collateral Circulation.—As after the previous operation.

LIGATION OF THE ANTERIOR TIBIAL ARTERY.

Indications.—(1) Wounds to the vessel (incised, punctured, gunshot, due to fracture and after amputations). (2) Traumatic aneurysm of the tibial artery. (3) Aneurysm of the popliteal artery according to some authorities.

Surgical Anatomy.— The popliteal artery bifurcates at the lower border of the popliteus muscle behind the knee-joint, into anterior and posterior tibial arteries. The anterior tibial passes over the upper border of the interosseous membrane along the anterior and outer aspect of the limb.

Surface Marking.— Take a point midway between the head of the fibula and the tuberosity of the tibia ; take another point midway between the internal and external malleoli. Join these two points to indicate the line of the artery (Fig. 27).

Position.—The patient lies on his back. The leg lies straight upon the table with the foot projecting beyond its edge. Extend

FIG. 27.
Surface marking of the anterior tibial artery.

foot forcibly and rotate leg fully inwards. Operator stands on the outer side and assistant opposite to him.

A. In the upper third of the Leg.
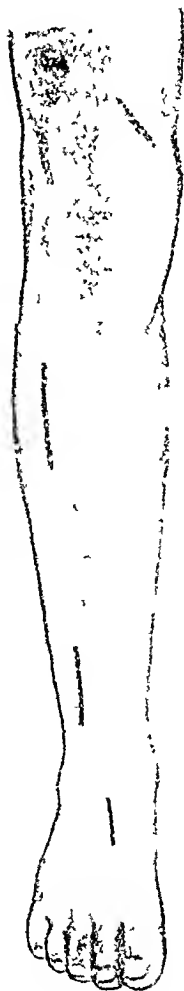
Operation.—Incision for the right side from above downwards and for the left from below upwards, three and half inches long over the line of the artery, its upper end being about one inch below the head of the tibia. The strong deep fascia, which is exposed, is divided. The intermuscular line between the tibialis anticus and extensor longus digitorum is now seen. Relax these muscles now by flexing the foot. Separate these two muscles, retract them and look for the external border of the tibia. The artery will be found lying bound down on the interosseous membrane. The nerve lies to the outer side of the artery. The needle is passed from without inwards and the artery ligatured with the venæ comites as the latter can hardly be separated (Fig. 28).

Comment.—(1) Before incision try to define the tibialis anticus. (2) One and half inch or a thumb's breadth on the outer side of the crest of the tibia will roughly define the line of the artery. (3) If the intermuscular line is not distinct, feel for it with your finger.

B. In the middle third of the Leg.

Operation.—Make an incision three inches long on the line of the artery with its centre opposite the centre of the limb, dividing the skin and the deep fascia. The white line indicating the intermuscular septum between the tibialis anticus and extensor longus hallucis is now exposed. Flex the foot to relax these muscles and separate them along this line and retract them. The artery will be found lying on the interosseous membrane. On its outer side is the extensor longus hallucis and in its front is the anterior tibial nerve. The needle is passed from its inner side.

Comment.—(1) Missing of the intermuscular septum can be avoided by (a) identifying the tibialis anticus which is the first muscle external to the crest of the tibia and (b) keeping close round its outer margin while opening the intermuscular septum. (2) Flex the foot to relax the muscles while looking for the artery.
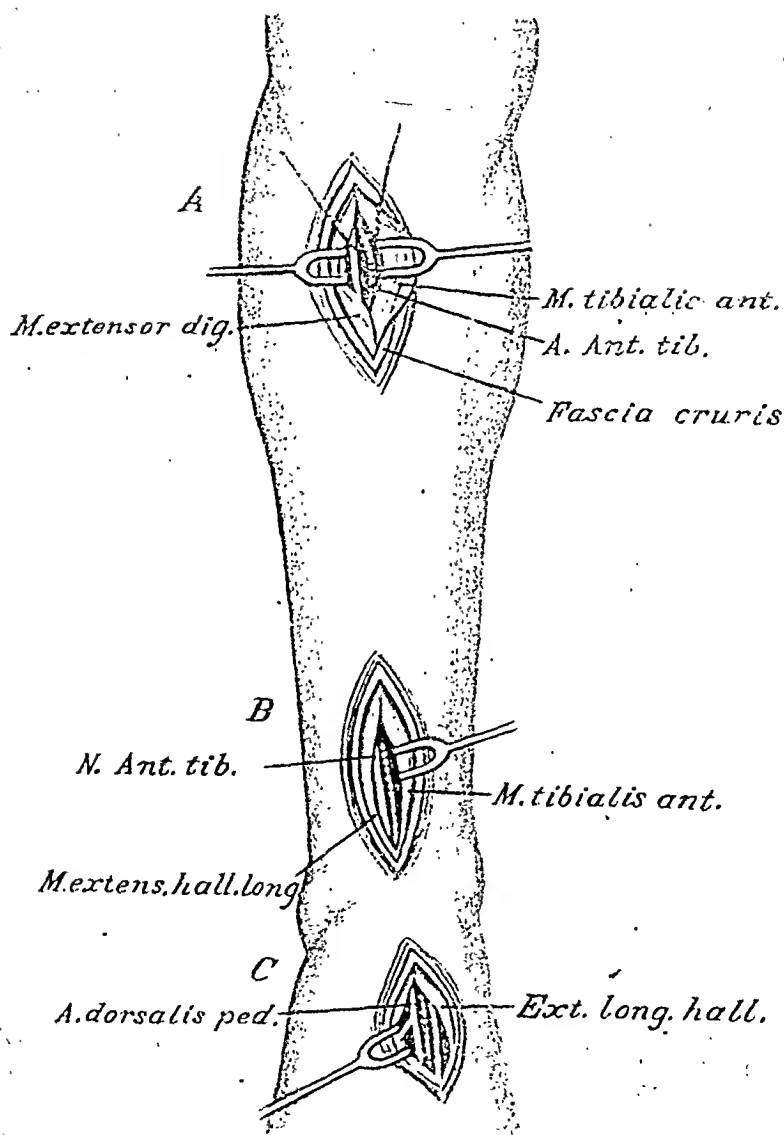
PLATE X.

FIG. 28—A. FIG. 29—B. FIG. 30—C.
Ligation of the anterior tibial artery.

C. In the lower third of the Leg.

Operation.—An incision two to three inches in length is made just to the outer side of the tibialis anticus tendon. Define the tendon. Expose the deep fascia and divide it. Retract the extensor longus hallucis externally. The artery is now seen with the nerve lying on its outer side. Pass the needle from without inwards (Fig. 29).

Comment.—(1) Do not mistake one tendon for the other. (2) Flexion of the foot in order to relax the muscles may be useful while looking for the artery.

LIGATION OF THE DORSALIS PEDIS ARTERY.

Indications.—(1) Wounds of the vessels. (2) Traumatic aneurysms. (3) Hæmorrhage from the plantar arch from trauma, or secondary hæmorrhage due to septic processes in the sole.

Surgical Anatomy.—It is a direct continuation of the anterior tibial artery commencing midway between the external and internal malleoli. It runs downwards through the first interosseous space to join the external plantar artery and thus form the plantar arch.

Surface Marking.—Take the mid-point between the two malleoli and join it by a line to the first interosseous space. The artery lies between the tendon of extensor longus hallucis (on the inner side) and extensor longus digitorum (on the outer side) (Fig. 27).

Position.—Flex the knee, the sole of the foot rests on the table. The assistant holds the foot in that position. Operator stands on the outer side.

Operation.—Make an incision two inches long on the line of the artery between the tendons of extensor longus digitorum externally and extensor longus hallucis internally. The artery is found on the fatty tissue lying on the bone, the anterior tibial nerve being on its outer side. Pass the needle from the nerve (Fig. 30).

LIGATION OF THE POSTERIOR TIBIAL ARTERY.

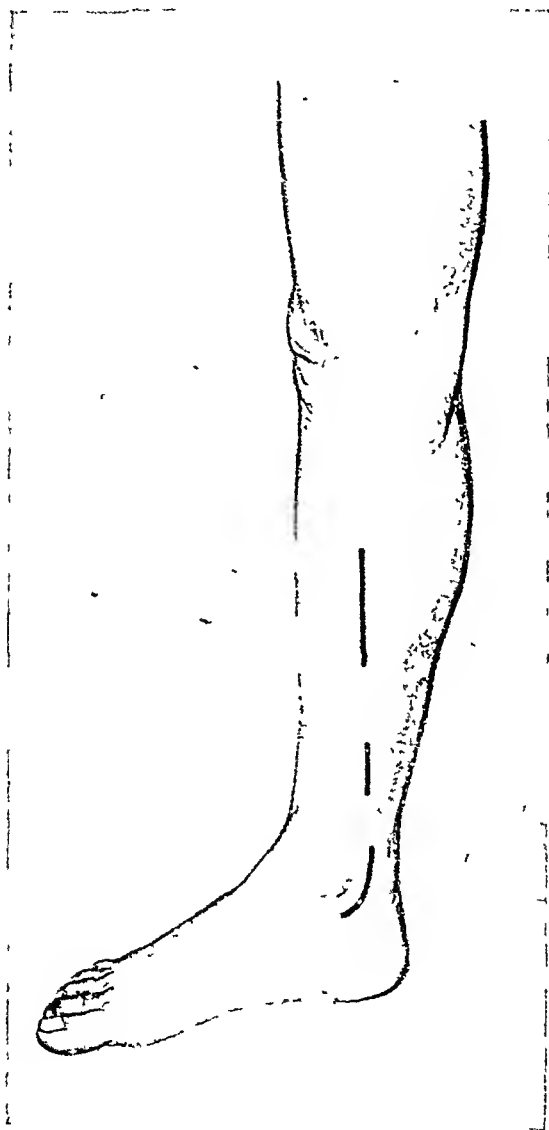**Indications.**—(1) Wounds (punctured, incised, gunshot, etc.). (2) Traumatic aneurysm.

FIG. 31.
Surface marking of the posterior tibial artery.

C, OS

4

Surgical Anatomy.—The posterior tibial artery formed by the bifurcation of the popliteal at the lower border of the popliteus muscle, continues down the back of the leg between the superficial (gastrocnemius, soleus, and plantaris) and deep (flexor longus digitorum) muscles on the posterior aspect of the tibia.

Surface Marking.—A line drawn from a point at the lower part of the centre of the popliteal space to another point midway between the tendo Achillis and the internal malleolus (Fig. 31).

Position.—Flex the knee and place the leg on its outer side. The assistant holds the leg in that position standing on the inner side of the leg. The operator stands on the outer side.

A. In the middle of the Calf.

Operation.—Make an incision four inches long parallel to and a finger's breadth behind the inner border of the tibia, its centre corresponding to the mid-point of the leg. Divide the skin avoiding the internal saphenous vein and then the deep fascia. If the gastrocnemius comes into view, draw the inner border downwards. This exposes the fibrous aponeurosis of the soleus. Divide this and the muscular fibres of the soleus along the length of the incision. Retract the cut margins. This brings into view the intermuscular aponeurosis which covers the vessels and the deeper muscles of the leg. Slit this up for the whole length. The flexor longus digitorum with its fibres running obliquely downwards is exposed. Plantar flex the foot and also the knee to relax the calf muscles. The vessel will be seen bound down to the deep muscles by a fascia. The posterior tibial nerve lies on the outer side. Pass the needle from the nerve (Fig. 32).

Comment.—(1) In muscular subjects, fleshy fibres of the gastrocnemius may be mistaken for soleus. The latter muscle can be recognised by the direction of its fibres running obliquely whereas those of the gastrocnemius run parallel to the long axis of the limb. (2) Sometimes the interval between the

PLATE XI.

A.Post. Tibial

N.Post. Tibial

M. Gastrocnemius

M. Soleus

Tendons Tibialis Posticus
Flex. Long. Dig.

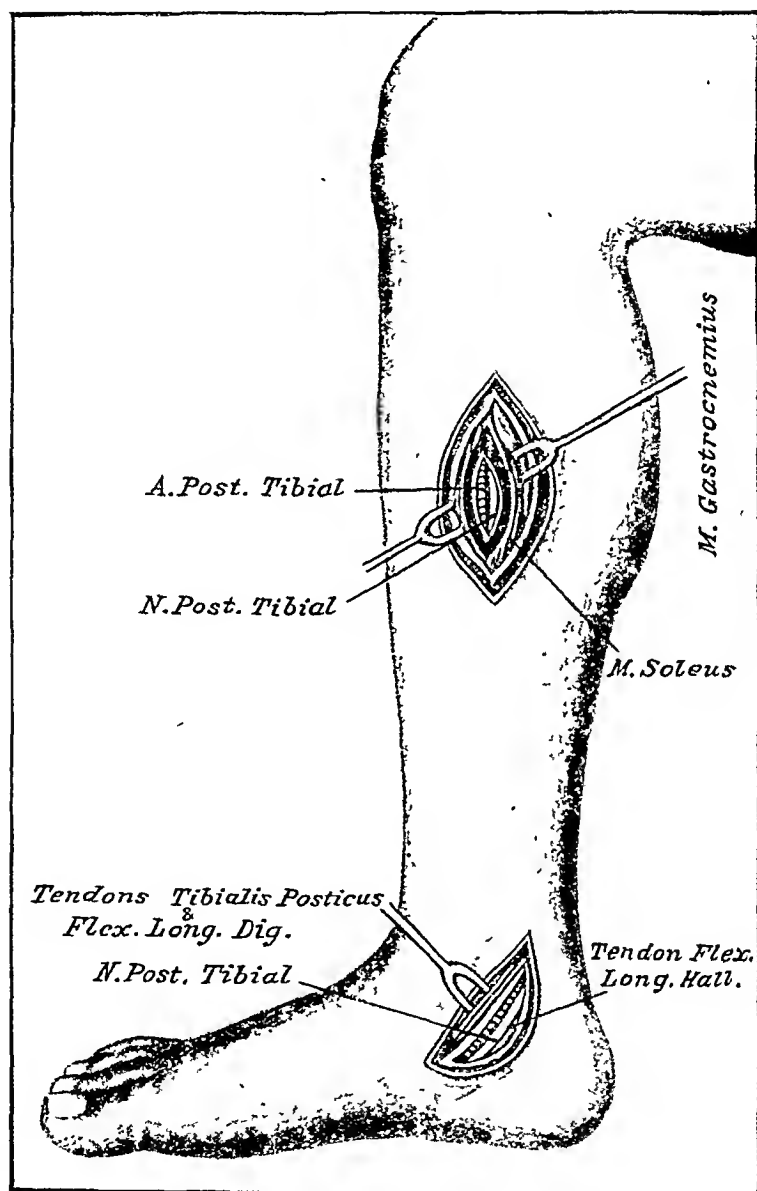N.Post. Tibial

Tendon Flex.
Long. Hall.

FIG. 32 and FIG. 33.
Ligation of the posterior tibial artery.

superficial and deep calf muscles is difficult to recognise and the deep muscles may be detached from the tibia by mistake. To avoid this, recognise the intermuscular aponeurosis of the soleus. (3) The fibres of the flexor longus digitorum may hide the artery and this can be obviated by searching for the artery behind the posterior surface of the tibia and not in the middle of the wound. (4) In dividing the soleus keep the knife towards the tibia or too much of the soleus will be cut.

B. At the lower third of the Leg.

Operation.—Make an incision two inches in length on the line of the artery midway between the margin of the tendo Achillis and inner edge of the tibia. Divide superficial and deep fasciæ with the upper part of the internal annular ligament. The artery is seen lying on the flexor longus digitorum with the nerve to its outer side. Pass the needle from the nerve and ligature it including the venæ comites.

C. Behind the internal Malleolus.

Operation.—Make a curved incision with the convexity towards the heel, half an inch behind the internal malleolus and corresponding to its curve. Divide the skin and the superficial fascia. The strong deep fascia which forms the internal annular ligament is exposed and divided. The artery is thus exposed with venæ comites lying on either side. It is separated from these and the needle passed from the nerve (Fig. 33).

Comment.—(1) From the inner margin of the internal malleolus towards the heel are found four compartments, (a) the first compartment contains tibialis posticus in its sheath, (b) the second, flexor longus digitorum, (c) the third, in order, the vein, artery, another vein and the nerve, (d) the fourth compartment contains flexor longus hallucis tendon. (2) Remember the order of the compartments and do not cut the tendon sheaths.

CHAPTER IV.

OPERATION ON NERVES.

Nerves may have to be exposed for the following objects :—

1. For nerve stretching (neurectasy), *e.g.*, the sciatic for sciatica.

2. For the division of a nerve trunk (neurotomy) for neuralgia, *e.g.*, the fifth cranial nerve.

3. For resection of nerve (neurectomy), *e.g.*, the spinal accessory for spasmodic torticollis.

4. For extrication of a nerve from cicatrix or callus (neurolysis).

5. For suturing (neurorrhaphy) in cases of accidental division or rupture, *e.g.*, the median in the forearm.

6. For nerve anastomosis, nerve bridging (neuroplasty) and nerve transplantation, *e.g.*, the facial with the hypoglossal or spinal accessory nerves.

7. For nerve implantation or nerve grafting.

EXPOSURE OF NERVES OF HEAD AND NECK.

THE SUPRA-ORBITAL NERVE.

Surgical Anatomy.—The nerve leaves the orbit through the supra-orbital foramen which is situated at the junction of the middle with the inner third of supra-orbital margin. The supra-orbital vessels are on its outer side and superficial to it.

Operation.—Steady the skin over the supra-orbital region with the left hand and make an incision about three-fourths of an inch long horizontally along the superciliary ridge keeping the supra-orbital notch at its centre. On cutting through the

integuments and the orbicularis muscle, the nerve is exposed. The vertical incision cuts across the fibres of the muscles and is not recommended.

THE INFRA-ORBITAL NERVE.

Surgical Anatomy.—This nerve is a branch of the second division of the fifth and emerges through the infra-orbital foramen on the front of the superior maxilla. To find the infra-orbital foramen, draw a line from the supra-orbital notch to the interval between the two lower bicuspid teeth ; the foramen lies on this line about half an inch below the infra-orbital margin.

Operation.—Make a transverse incision three-fourths of an inch long and one-fourth of an inch below the lower margin of the orbit, crossing the infra-orbital foramen. This incision cuts through the subcutaneous fat and orbicularis muscle and exposes levator labii superioris. This is divided and the nerve is reached.

THE FACIAL NERVE.

Surgical Anatomy.—The seventh or the facial nerve after traversing the internal auditory meatus and aqueductus Fallopii emerges through the stylo-mastoid foramen. It now runs forward and slightly downwards along the upper border of the posterior belly of the digastric, gives off the posterior auricular nerve and muscular branches, and enters the substance of the parotid gland at the level of the lower margin of the tragus, opposite the posterior border of the ramus of the lower jaw. It divides into two main branches, the temporo-facial and cervico-facial.

Position.—Same as for ligature of common carotid artery.

Operation.—Make an incision similar to that employed for ligature of the external carotid but at a slightly higher level. This divides the skin and the fascia ; the sterno-mastoid is cleared and retracted backwards. Similarly the parotid

gland is cleared and pulled forward. This part is cleared up to the posterior belly of digastric ; the nerve is found above it and accidental stimulation gives rise to facial spasm. The nerve is raised on an aneurysm needle and traced back to the stylo-mastoid foramen.

THE SPINAL ACCESSORY NERVE.

Surgical Anatomy.—The nerve leaves the cranial cavity through the jugular foramen and runs down the neck between the internal carotid and the jugular vein. It then passes obliquely downwards and backwards across the vein beneath the posterior belly of the digastric, and piercing the sterno-mastoid by its deep surface it passes through the muscle, crosses the posterior triangle to become distributed to the trapezius.

Position.—Patient lies on his back and in order to expose the anterior and posterior triangles of the neck a sand bag is placed behind shoulder and the chin turned to the opposite side.

Operation.—Make an incision three inches long from the apex of the mastoid process along the anterior border of sterno-mastoid muscle dividing the skin and then the deep cervical fascia. Feel for the transverse process of the atlas. Bend the neck slightly on the same side and retract the sterno-mastoid backwards. Identify the posterior belly and the lower margin of the digastric, and the nerve will be seen emerging from beneath it a little below and external to the transverse process of the atlas. It can now be stretched or excised for severe spasmodic wry-neck.

EXPOSURE OF THE NERVES OF THE UPPER EXTREMITY.

THE MEDIAN NERVE.

This nerve has to be exposed for suturing after accidental division. It may be exposed in three different situations,

viz.: (*a*) in the middle of the upper arm, (*b*) at the bend of the elbow, and (*c*) above the wrist.

(a) In the middle of the arm.—It can be exposed by the same process as the brachial artery. The nerve is seen first and then the artery (Fig. 15).

(b) In the front of the elbow.—The operation is similar to that for the exposure of the brachial artery in this situation. The incision, however, can with advantage be made about half an inch internal to the biceps tendon. The nerve lies one fourth of an inch internal to the artery (Fig. 16).

(c) Above the wrist.—It can be exposed about an inch above the transverse crease on the front of the wrist. A vertical incision there exposes the palmaris longus tendon and the nerve will be found lying either beneath or just on the radial side of this tendon.

THE ULNAR NERVE.

This nerve is generally injured in the ulnar groove at the back of the elbow or just above the wrist.

(a) In the upper arm.—The nerve can be exposed by the same incision as for the brachial (Fig. 15). The nerve lies on the inner side of the vessel. Lower down the nerve can be exposed by an incision on the ulnar groove at the back of the internal condyle or by prolonging the incision upwards.

(b) In the forearm.—The nerve can be exposed by the same incision as for the ulnar artery (Fig. 18). The nerve lies internal to the vessel.

THE MUSCULO-SPIRAL NERVE.

This nerve is frequently damaged in fractures of the shaft of the humerus or it may get caught in the callus after the fracture is united. It may give rise to wrist-drop. It is usually exposed at the back of the arm.

At the back of the arm.—Flex the elbow at right angles holding the upper arm in the vertical position. Make a vertical incision four inches long in the middle line of the posterior aspect of the arm, the centre of the incision being opposite the centre of the bone. The triceps is exposed and its fibres separated vertically. The nerve is found in the musculo-spiral groove with the superior profunda vessels crossing the line of incision obliquely.

EXPOSURE OF THE NERVES OF THE LOWER EXTREMITY.

THE SCIATIC NERVE.

Surgical Anatomy.—The nerve appears immediately below the inferior border of the gluteus maximus. It lies on the adductor magnus between it and the hamstring muscles. This nerve is exposed for stretching in cases of obstinate sciatica but this operation is, however, becoming very rare.

Position.—The patient lies prone with his head turned to one side. The operator stands on the side to be operated on.

Operation.—Commence an incision at a point midway between the ischial tuberosity and the great trochanter and carry it vertically downwards for three inches. This exposes the gluteus maximus above and hamstring muscles at the inner margin of the wound. They are retracted upwards and inwards respectively. The sciatic nerve is found lying on the posterior surface of the adductor magnus in the depth of the wound.

THE EXTERNAL POPLITEAL NERVE.

Surgical Anatomy.—This nerve is one of the two terminal branches of the great sciatic nerve and lies close to the outer side of the popliteal space, and crosses the outer head of the gastrocnemius to the neck of the fibula immediately behind or below the tendon of the biceps femoris.

Position.—Flex the limb and rotate it fully inwards.

Operation.—Identify the biceps femoris tendon and make an incision two inches long and parallel to it in such a way that the centre of the incision corresponds to the point of insertion of the tendon. Divide the skin and retract the flaps ; the nerve will be found behind and below the tendon.

CHAPTER V.

TENOTOMY.

Tenotomy can be performed in one of the two ways: (*a*) *The subcutaneous method* has for its object the division of the tendon with the least disturbance of the surrounding parts and with the smallest opening in the skin. In pre-antiseptic days this was the operation of choice, but at present the open method is advocated. The subcutaneous method has certain advantages :—(1) It is simple and leaves no scar. (2) It is suitable for well defined tendons which have no important structures near it. (*b*) *The open method* should be chosen : (1) When there are important structures surrounding the tendon. (2) When tenotomy is only a part of the operation for the cure of deformity.

Indications.—

(1) For the relief of deformities :—

(*a*) Due to infantile paralysis.

(*b*) Resulting from spastic paraplegia ; in these cases improvement follows the division of tendons of such muscles as are in a state of spastic contraction.

(*c*) Of traumatic origin ; these are due to cicatricial contraction from the wounds, burns, etc., especially if the patient keeps his limb in a particular position for any length of time.

(2) For torticollis of the non-spasmodic form.

(3) In certain cases of congenital deformities.

(4) To prevent tilting of the heel after certain operations such as, Chopart's amputation.

Instruments.—Group XXXI.

Operation.—Subcutaneous tenotomy. The tendon, if it is not already prominent, should be made so by the disposition of the limb, but it should not be over-stretched. Attempt should be made to cut the tendon without opening its synovial sheath. There are two methods :—

(1) The sharp tenotome is entered through the skin close to the tendon to make a way for the blunt-pointed tenotome. The latter is now introduced through the opening, in the flat position, so that the edge, on entrance, is not in contact with the tendon. It enters on the deeper side of the tendon, *i.e.*, the tendon lies between it and the skin. The edge is now directed towards the tendon, and it is cut with a sawing movement while the assistant is putting the tendon more and more on the stretch.

(2) In the other method, after the skin puncture, the blunt-pointed tenotome is introduced superficial to the tendon, *i.e.*, between the tendon and the skin and the tendon is cut from the side of the skin towards the deeper structures. The left forefinger is kept on the skin at the site of operation in order to feel the movements of the tenotome and to control it. The division of the tendon is felt by a creaking sensation and a snap.

TENDO ACHILLIS.

Indications.—(1) Chiefly for talipes equinus. (2) To rectify deformity which may be caused by Chopart's amputation, but this amputation has practically been given up. (3) It is occasionally necessary in order to reduce a dislocation or fracture of the foot, *e.g.*, Pott's fracture.

Operation.—Select the position and divide where the tendon is the narrowest, which is about an inch and a half above the heel (Fig. 34).

TIBIALIS POSTICUS.

Indications.—In cases of congenital club-foot and other deformities.

Surgical Anatomy.—The tendon passes along the posterior aspect of the tibia into the first of the four compartments beneath the inner malleolus, occupying a special synovial sheath (Fig. 33). It is inserted into the scaphoid, the cuneiform, the cuboid and the second and third metatarsal bones.
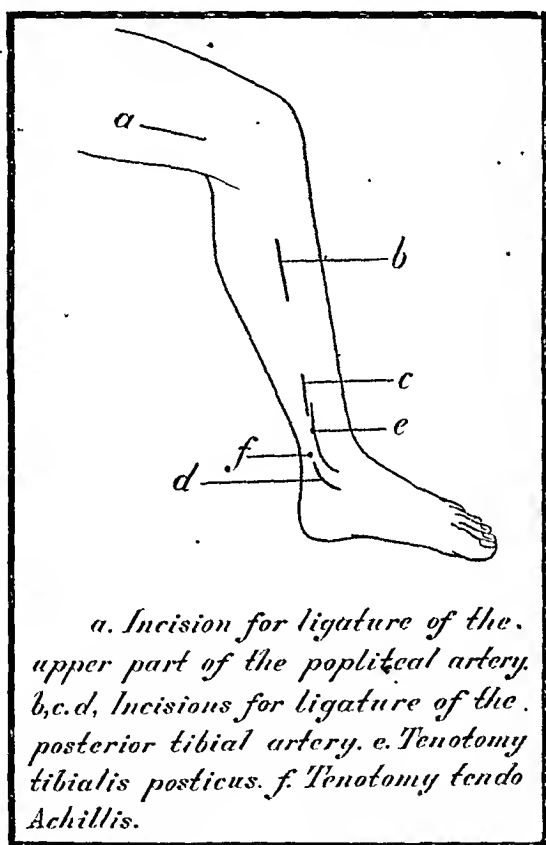

a. *Incision for ligature of the. upper part of the popliteal artery. b,c.d, Incisions for ligature of the. posterior tibial artery. e. Tenotomy tibialis posticus. f. Tenotomy tendo Achillis.*

FIG. 34.

It is in close relation to important structures as described before.

Operation.—It should be divided by the open method either (*a*) above, immediately before it passes under the internal annular ligament or (*b*) below, and just behind its insertion into the tuberosity of the scaphoid (Fig. 34).

TIBIALIS ANTICUS.

Indications.—This muscle which is a powerful adductor of the foot is divided to overcome deformities such as talipes equino-varus.

Surgical Anatomy.—After passing through the innermost sheath, in the anterior annular ligament, the tendon of the tibialis anticus crosses the ankle in front lying upon the astragalus, scaphoid, and the internal cuneiform bones and the ligaments uniting them, to be inserted into the internal cuneiform and the base of the first metatarsal on their inner aspects. It has its own synovial sheath.

Operation.—It is divided as it crosses the scaphoid bone, on the inner side of the foot to gain insertion into the base of the first metatarsal and the internal cuneiform bones.

HAMSTRING TENDONS.

Indications.—(1) In cases of ankylosis of the knee due to the contraction of these tendons, from injury, disease, or after operation. (2) As a preliminary measure to an operation for shortening these tendons or for tendon-grafting, in cases of paralysis of extensor tendons of the infantile type.

Surgical Anatomy.—Hamstring tendons consist of the biceps, semi-membranosus and semi-tendinosus. The biceps tendon is the strong cord which forms the outer boundary of the popliteal space. It is inserted into the head of the fibula. Along its posterior border runs the external popliteal nerve. The semi-membranosus and the semi-tendinosus tendons with the sartorius and gracilis, form the inner boundary of the popliteal space. The semi-tendinosus is smaller, more superficial and placed nearer the middle line than the semi-membranosus. The gracilis and the sartorius tendons are more difficult to feel.

Division of the biceps femoris tendon.—In consideration of its close relation to the external popliteal nerve which can be

easily injured during subcutaneous tenotomy, the open method should be adopted. An incision half an inch long is made on the outer aspect of the tendon ;. the tendon is defined and separated from the nerve. It is then divided in the usual way.

Division of the semi-membranosus and semi-tendinosus tendons.—A subcutaneous tenotomy is not attended with any particular risk. The tenotome is introduced beneath the tendons and cut towards the skin.

PERONEI TENDONS.

Indications.—(1) Rarely in advanced cases of valgus due to infantile paralysis. (2) For tendon-grafting.

Surgical Anatomy.—The two peronei tendons pass into the foot behind the outer malleolus, grooving it deeply as they run beneath it. They have a common synovial sheath, the peroneus brevis being the upper of the two tendons. The peroneus longus crosses the foot obliquely and is inserted into the under-surface of the internal cuneiform and the base of the first metatarsal bones.

Operation.—It is divided two inches above the external malleolus, the guide being the posterior margin of the fibula.

THE STERNO-MASTOID.

Indications.—(1) Permanent wry-neck generally seen in early infancy, as a result of injury during childbirth or in later life due to gummatous infiltration. The sternal head is more contracted and is often converted into a firm fibrous cord. In this respect it differs from deformities of the talipes variety due to infantile paralysis, where the contraction occurs in healthy muscles.

(2) The tendons have sometimes to be divided in the course of certain operations, *e.g.*, ligature of the innominate artery. This part of the sterno-mastoid muscle is in close relation with important veins, *viz.*, the internal jugular on its deep surface, the external jugular behind its posterior border, and the anterior

jugular crossing its inner margin. Moreover, the deep cervical fascia makes a separate sheath for this tendon and undergoes contraction with the tendon. In tenotomy of this tendon the fascia has to be divided and an attempt to perform this by the subcutaneous method is attended with the risk of injuring the veins. This operation should, therefore, be performed by the open method. The tendon should be rendered tense by a sandbag placed under the neck. An oblique incision is made across the lower end of the sterno-mastoid and the tenotomy is performed through this opening.

CHAPTER VI.

AMPUTATIONS.

Preliminary Remarks.

In former days, in amputating a limb, there used to be one object in view, quickness of operation. Since the introduction of anæsthetics and antiseptic and aseptic methods into surgery, the operator is guided by other ideas, *viz*.: (1) to avoid unnecessary sacrifice of tissues, (2) to obtain the best end-results of amputation by keeping sufficient skin and muscle covering for the stump for wearing an artificial limb, and (3) rapid healing of the wound.

The word amputation denotes any operation by which a limb or any integral portion of a limb is severed from the rest of the body. It is, however, preferable to subdivide amputations into two distinct groups, *viz*.: (1) amputations proper or those in which the limb is removed after division of bone, and (2) disarticulations, *i.e.*, those in which removal is effected through one of the joints.

Indications for amputations.—Advances in modern technique and wound treatment have greatly reduced the number of amputations, either in civil or war hospitals. Each case has to be considered on its merits. Amputation of a limb should never be performed, unless it is absolutely necessary in order to save the patient's life. Esmarch's indications are based on sound surgical judgment ; these can be classified and summarised as follows :—

(1) Extensive fractures of bones, *e.g.*, comminuted, simple fractures or compound fractures.

(2) Extensive laceration of soft tissues such as muscles, vessels and nerves.

(3) Obstruction or laceration of large blood vessels which might lead to gangrene.

(4) Extensive destruction of skin, where skin-grafting is impracticable.

(5) Gangrene of a part of a limb.

(6) Severe septic conditions of the bone or soft tissues, *e.g.*, diffuse osteomyelitis, necrosis, etc., endangering the patient's life or rendering the limb useless.

(7) Malignant tumours of the soft tissues or of the bone.

(8) Certain conditions of the limb when it is an useless encumbrance to the patient, *e.g.*, irreparable deformities with callosities, contracture and ankylosis.

Instruments.—Group III.

METHODS OF AMPUTATION.

The oldest method of amputation was the circular method as was practised by Celsus. It consisted of a simple transverse incision of all the soft tissues down to the bone · in the same plane. Various methods have since developed, in which much deliberation and economy is exercised in fashioning skin flaps, muscle-and-skin flaps and the cutting of skin and muscle at different levels. The objects to be aimed at are as follows :—

(1) To leave the maximum of healthy tissues.

(2) The flaps to be so designed that they should have ample blood supply and the danger of sloughing is avoided.

(3) The skin and the muscles are cut in such a way that the bony stump has sufficient cushion of muscles, and the muscles an adequate covering of skin.

(4) The resulting scar on the skin is left in a position in which it will not be subjected to pressure or friction. The following are the methods generally adopted.

I. Circular amputation.

It is only done when the question of rapidity of operation overweighs all other considerations. It leaves the scar **over**

the divided bone. The edges of skin are difficult to approximate without putting them under considerable tension. It is most unsuitable for the lower limbs. It may, however, in rare instances, be performed on the upper extremities.

Operation.—The right hand holding the knife passes under and encircles the limb in such a manner that the tip of the blade points towards the operator's chest. With one clean sweep of the knife a circular division of the skin and superficial fascia is made. The skin now retracts. The assistant forcibly retracts it further up as much as possible. The muscles and periosteum are then divided down to the bone with another circular sweep of the knife on a level with the retracted skin.
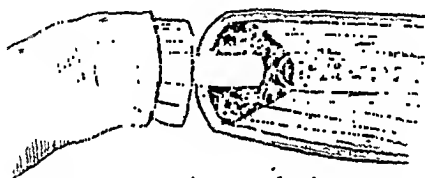
Amputation

Transverse Circular Incision.

Sagittal section showing cone which is left after sawing through the bone. (Kocher) (Correct method)

FIG. 35.

The muscles are then retracted and the periosteum is reflected up to the line of the future bone-section by a periosteal elevator. The assistant now retracts all the divided soft tissues by retractors as high up as possible. Now the saw is used on the bone working it from point to heel. The assistant must hold the limb in such a way that the saw is not caught in the bone while dividing it (Fig. 35).

II. Modified circular amputation.

This method has greatly replaced the circular amputation and is suitable for the arm and the forearm.

Operation.—There are three different modifications :—

(*a*) A circular cut is made through the skin and fascia as in the circular method (Fig. 35). A vertical incision is then made from above downwards to join the original one. The skin is raised from the vertical cut towards the rest of the circle and forms two rather imperfect skin-flaps .

(*b*) Two vertical incisions are made to join the circular wound. Two square skin-flaps are dissected up and the muscles divided circularly as in the circular amputation (Fig. 39).

(*c*) Two short semilunar flaps of equal width and length are dissected up. They are composed of the skin and subcutaneous tissue. The small flaps having been raised, the skin is retracted as a whole and the muscles are divided by circular incision as in circular amputation (Fig. 39).

III. The flap method.

By this method one or two flaps composed of skin and subcutaneous tissue (skin-flaps), or those composed of skin and muscle (skin-and-muscle flaps) are raised. When there are two flaps they may be equal or unequal in length and they may be so fashioned that one is placed anteriorly and other posteriorly in relation to limbs, *antero-posterior flaps*, or they may be placed laterally, *lateral flaps*.

The skin-flaps are liable to slough from insufficient blood-supply unless they are raised from the neighbourhood of joints where the skin has a greater vascular supply, *e.g.*, Stephen Smith's disarticulation of the knee-joint.

The skin-and-muscle flaps naturally have a better blood-supply, but they are sometimes rather unwieldy (Fig. 46).

The length of the flaps.—The skin retracts about one-third of its original length when divided and therefore in fashioning flaps, the length of a single flap or the combined length of two flaps should at least be equal to the diameter of a limb plus one-third, at the level of the bone-section.

Methods of cutting flaps.—(1) Cutting by transfixion. This is an old method which has practically been superseded by one of the following methods.

(2) The simple skin flap. The flap or flaps are marked out by an incision, skin and subcutaneous tissue deep. The flap is raised and allowed to retract ; the muscular tissue is cut unevenly in such a fashion that the thinnest section lies nearer the margin of the flap and the thickest at its base.

(3) The skin-and-muscle flap. Mark out the flap by a skin incision. The skin is allowed to retract evenly. The muscles are then cut obliquely from near the margin of the skin flap, and the deeper part of the soft tissues are either raised by dissection or peeled off from the bone.

Three-tailed gauze Retractor.
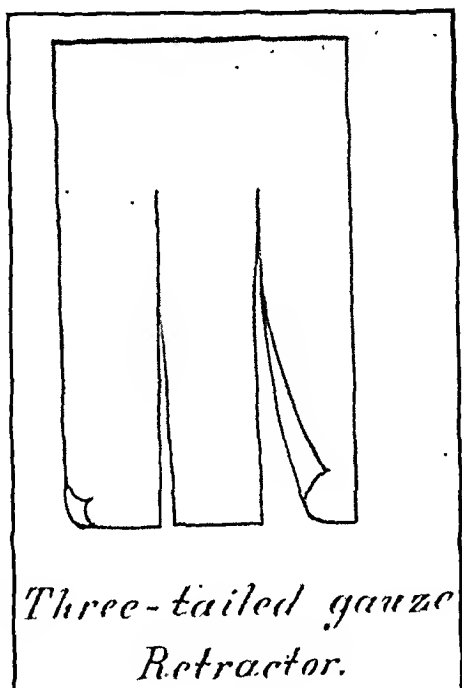
FIG. 36.

IV. The racket method.

This method consists of a vertical incision representing the handle of a racket which bifurcates at its lower end into two incisions, which may be called the two limbs of the racket. This part of the incision, therefore, takes the shape of an inverted Y (λ). The ends of these two incisions are joined by another slightly rounded one. The limbs of the racket may be equal or unequal according to the position in which the line of suture can be left with advantage (Fig. 37). This method is suitable

in disarticulating the shoulder and some of the smaller joints, *e.g.*, the toes and fingers.

V. Elliptical method.

This is an intermediate method between the circular method and amputation by a single flap. The skin incision takes the shape of an ellipse. The skin and subcutaneous tissues are reflected and retracted. The muscles are divided as in the circular method.

Other modifications which have been introduced in recent surgery with reference to bone stumps are as follows :

VI. Osteoplastic method.

In this the raw bone surface and the medullary canal are covered by a bone flap with a normal periosteum.

VII. Tendinoplastic method.

In this the sawn surface of bone is covered by a broad tendon which is stitched to the periosteum.

VIII. Aperiosteal method.

In this a portion of the periosteum and bone marrow is removed from the end of the bone, in order to prevent the growth of irregular spicules of bone on the stump from the osteogenetic layer of the periosteum.

DEFECTS OF AMPUTATION.

In amputations the following should be avoided :—

(1) Conical stump. This arises when the muscles and skin covering the bone are short and they are brought together too tightly round the bone stump. The muscles retract and undergo atrophyf leaving a cone-shaped stump which is not adapted to bear the weight. Remember that some muscles retract more than others. The other cause of conical stumps is sepsis, giving rise to the formation of a

scar and, therefore, contraction of the soft tissues on the bone. The rate of growth of bone according to age should also be remembered. In children the bone may grow out of proportion to the soft tissues covering them.

(2) Splitting of vessels, while making vertical skin incisions.

(3) Leaving an ill-nourished skin-flap which leads to sloughing.

(4) Leaving the cut ends of nerves too long. These might get caught in the cicatrix or callus giving rise to painful stumps. It has also given rise to neuromata and neuritis.

HÆMORRHAGE.

Hæmorrhage in amputations can be controlled by one of the following methods :—

(1) Digital compression as in the case of disarticulation of the shoulder.

(2) Postural method, *viz.*, (*a*) elevation of the limb, (*b*) Trendelenburg position in cases of amputations of the lower limbs.

(3) Preliminary ligature of the main artery on the proximal side.

(4) Tourniquets. (*a*) The metal screw-tourniquet by which the pressure is limited to the main artery only. (*b*) Esmarch's elastic tourniquet, in this case Esmarch's rubber bandage is applied tightly from the distal to the proximal part rendering the part bloodless and then the elastic tourniquet is applied where the rubber bandage ends, proximally. The elastic bandage is then removed before the operation is commenced. This serves two purposes. First of all, the bandage expels blood from the part to be amputated, and secondly, the tourniquet prevents entrance of blood any more into the vessels. (*c*) Pneumatic tourniquet of Perthes, a hollow rubber band is used which is inflated with air by means of a tubing and pump. (*d*) Lynn-Thomas' forceps tourniquet which has

one blade serrated and the other smooth rounded and probe-pointed. The probe-pointed blade is inserted through a small opening into the soft tissues, deeper to the vessels. The serrated blade is applied to the skin. The skin and the soft tissues with the vessels in it are compressed between the two blades, and when the forceps are clamped, it effectually stops bleeding.

(5) Previous administration of calcium chloride, normal serum or coagulin (coagulose).

CHAPTER VII.

AMPUTATIONS OF THE UPPER EXTREMITY.

1. THE FINGERS AND THE THUMB.

An attempt should always be made to leave as much as possible of a digit, particularly that of the thumb and index finger. Even a small stump which is not neat looking is wonderfully useful. As much of the little and ring fingers should be saved as possible, where the other fingers have to be amputated. A very well contrived artificial limb can never take the place of a partially amputated limb. Divide the bone as low as possible. The base of the terminal phalanx has the flexor profundus tendon attached to it, it should be preserved whenever possible. In the second phalanx, at least the upper third should be preserved for the insertion of the flexor sublimis digitorum. Try to ascertain the line of inter-phalangeal and metacarpo-phalangeal articulations. The knuckles on the dorsum of the fingers when the joints are flexed, lie above the joint line.

In making a flap they should be cut comparatively long, as the long bones of the fingers do not have a correspondingly large soft part to cover. The palmar skin is thicker and more vascular than the dorsal, so an attempt should always be made to keep as much of palmar flap to cover the stump as is available. Besides, the flap should be so fashioned that the scar is not over the stump or upon its palmar aspect. Whenever possible, the fibrous sheath of the tendons should be closed, as while the tendons themselves retract, the sheaths do not, and they may form a channel for the passage of sepsis in cases of accidental or unavoidable infection.

Instruments.—Group III.

Position.—The operator stands in front and holds the finger to be amputated between his forefinger and thumb. The assistant, standing on one side, holds the adjacent fingers out of the way or retracts them by gauze retractors. (Fig. 36).

A. The terminal phalanx.

AMPUTATION OF THE TERMINAL PHALANX BY DISARTICULATION THROUGH THE TERMINAL INTER-PHALANGEAL JOINT.

Operation.—Make an incision down to the joint on the dorsal aspect of the finger about one-eighth of an inch below the knuckle of the terminal joint. Open the joint and cut the lateral ligaments ; now pass the blade of the knife through the joint round the base of the terminal phalanx, keeping the knife closely applied to the bone and carrying it towards the tip of the finger. Complete this flap by bringing the knife out at right angles to the palmar surface. The small phalangeal vessels hardly need ligaturing. (Fig. 37).

Comment.—(1) Do not make the flap pointed or triangular, keep a broad margin to it. (2) Do not scrape the inter-articular cartilage of the middle phalanx. (3) This operation can also be performed by raising the palmar flap from the tip of the finger upwards and then disarticulating the joint.

B. The second phalanx.

PARTIAL AMPUTATION OF THE FINGER BY DISARTICULATION THROUGH THE SECOND INTER-PHALANGEAL JOINT.

Ascertain the line of the joint which is about one-fifth of an inch below the knuckle, and keep a palmar flap similar to the above operation. (Fig. 37).

C. The metacarpo-phalangeal joint.

AMPUTATION OF THE WHOLE FINGER BY DISARTICULATION THROUGH THE METACARPO-PHALANGEAL JOINT.

This may be done by the racket method, (a) in the case of all the other fingers with equal limbs to the racket, (b) for

the little and index fingers with unequal limbs to the racket. The joint is found a third of an inch below the knuckle.

Operation.—Commence a vertical incision at the lower third of the metacarpal bone, and carry it down in the middle line beyond the base of the phalanx ; it then bifurcates and its equal limbs run obliquely towards the palmar aspect ending in a line with the free margin of the web. A transverse palmar incision, just below the crease between the finger and the palm, joins the two limbs. Enter the knife upon the dorsum from one side to the other and then deepen it into the palmar cut. Hyper-extend the finger, deepen the palmar incision to the bone, cutting through the flexor tendon. Turn the finger first to the right, then to the left, in order to carry the lateral incision to the bone. The digital arteries are now cut across and the lumbrical and extensor tendon expansions are also cut. Dissect the flaps back as far as the joint line. Return to the palmar aspect, extend the finger and open the joint. Cut the glenoid and the lateral ligaments and then the extensor tendon. The synovial sheath may be closed. The glenoid ligament is left in the stump and the digital arteries ligatured. The flaps are united in a vertical direction. (Fig. 37).

Amputation of the index and little fingers (by modified racket method).

A modification of the racket incision is necessary in the case of these two fingers, in order to keep the cicatrix away from an exposed position and pressure. In order to obtain this result the limbs of the racket should be unequal. (Fig. 37).

For the index finger.—The incision on the dorsum representing the handle of the racket is made nearest to the middle finger. The incision representing the outer limb of the racket runs more vertically downwards than that for the inner limb, which runs more transversely inwards, towards the web. This leaves a larger outer flap which when united to the inner flap leaves the scar on the inner side and not exposed towards the thumb. (Fig. 37).

PLATE XII.

AMPUTATION.

Farabœuf's amputation at seat of election.

Modified circular method (the skin flap would be more suitable if made unequal in length)

X indicates the position of the saw-line.

Incision for Syme's disarticulation through the ankle-joint.
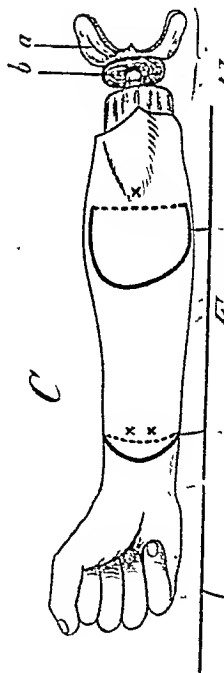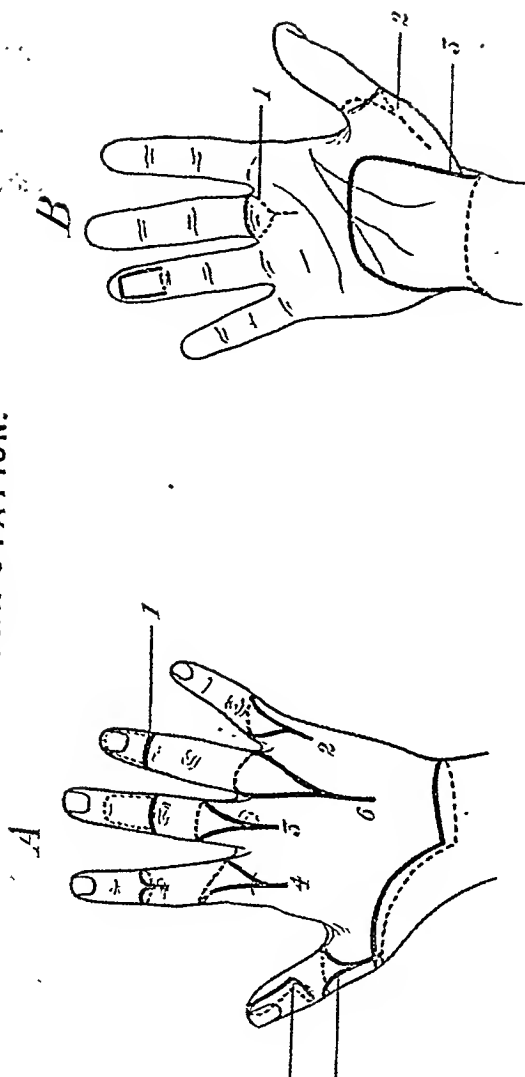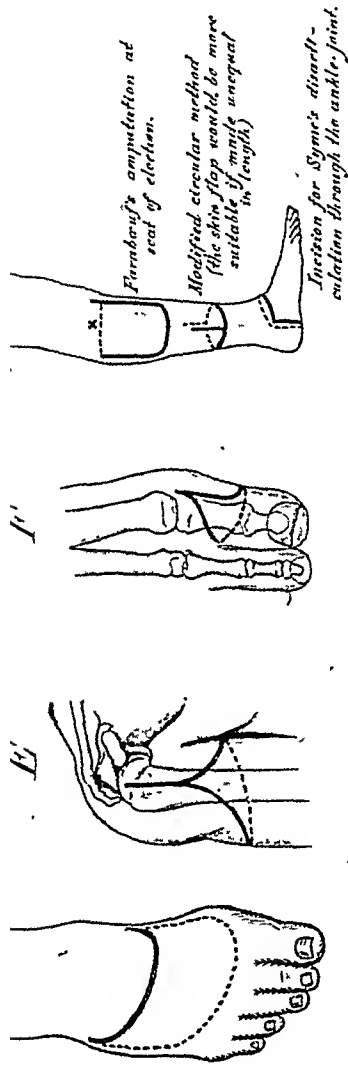
A.—1. Last phalanx by long palmar flap; 2.3.4.5. Through metacarpo-phalangeal joint by racquet incision. 6. Finger with metacarpal bone by a racquet incision.

B.—1. Racquet incision for metacarpo-phalangeal joint; 2. Thumb with metacarpus by racquet incision: 3. Amputation through the wrist by long palmar flap.

C.—1. Modified circular amputation of forearm: 2. Through Elbow joint by long anterior flap: 3. Modified circular amputation of the arm: (a) Skin flap (b) Circular division of muscle.

D.—Lisfranc's amputation.

E.—Spence's Amputation at the Shoulder by Anterior Racquet.

F.—Farabœuf's Amputation of the Great Toe.

G.—Incision for Amputation for the Lower Extremity.

FIGS. 37-43 corresponds to A—G consecutively.

For the little finger.—The vertical cut is made on
the side nearest the ring finger and the incision for the limbs
made in such a way, that it leads to a larger internal flap. The
cicatrix lies towards the ring finger and therefore not exposed
to pressure and injury. (Fig. 37).

AMPUTATION OF THE THUMB BY DISARTICULATION THROUGH THE METACARPO-PHALANGEAL JOINT.

Position.—The hand has to be held in a pronated or
supinated position according to convenience and the stages
of the operation. The assistant stands facing the operator,
steadies the hand and holds other fingers out of the way of
the operator.

Operation.—The racket method is most suitable. The
incision is commenced three-quarters of an inch above the
joint on the dorsum, and is carried along the outer side of the
long extensor tendon to a little beyond the base of the first
phalanx. Here it bifurcates to form the two limbs. The
inner limb is carried directly across the web of the thumb on
to the palmar aspect. The outer limb is carried down almost
to the inter-phalangeal knuckle. The lower ends of the limbs
are then joined by an incision on the palmar aspect. The
rest of the operation is similar to that of disarticulation of a
finger through metacarpo-phalangeal joint. The two extensor
tendons are divided opposite the joint line. Flexor longus
policis tendon is cut at the level of the palmar incision and
attached to the sesamoid bone which is left on the stump.
The digital vessels are secured. (Fig. 37).

II. THE METACARPALS.

AMPUTATION OF THE FINGERS AND THUMB TOGETHER WITH THE METACARPUS.

Position.—The limb is held in pronation. The operator
grasps the finger with his own hand in supine position. The
assistant stands opposite, steadies the hand and keeps the
other fingers out of the way by gauze retractors. (Fig. 36).

Disarticulation of the fingers with its metacarpal bone. (Fig. 37).

Operation.—Determine the joint line. Commence the incision for the handle of the racket just above the articulation, carry it down on the dorsum of the metacarpus to the base of the knuckle. Here the two equal limbs cross the web and meet on the palmar aspect at the digito-palmar fold. This incision is only skin deep. Now deepen the dorsal incision and divide the extensor tendons on a level with the upper end of the skin incision. Free the sides of the shaft of the metacarpal bone, of all structures keeping the blades of the knife close to the bone. The finger can be rotated inwards or outwards to facilitate this. Retract the skin and introduce the knife between the bases of the contiguous metacarpal bones, to divide the interosseous ligament; turning to the lower ends of the incision at the head of the metacarpal bones, the soft tissues near the web of the finger and those on the palmar aspect are cut through. The flexor tendons are now cut across along the level of the neck of the metacarpal bones; now, over-extend the finger. Divide the ligaments of the joint, separate the soft tissues from the shaft on the palmar aspect of the bone as far back as possible. Now pull it back upon the dorsum of the hand and divide such structures as may be still holding the shaft on the palmar aspect. The digital arteries will be cut near the web.

In the case of the index and little fingers, the skin incision will have to be modified in the same way as in amputations through the metacarpo-phalangeal joints.

THE WRIST.

AMPUTATIONS OF THE HAND BY DISARTICULATION THROUGH THE WRIST-JOINT.

The different flaps for this operation are :

(1) Elliptical incision.

(2) The long external flap of Durbueil.

(3) A modified circular incision.

(4) A long palmar flap.

The last is recommended because, (*i*) it gives the best covering for the stump, (*ii*) the cicatrix lies on the dorsal aspect, (*iii*) the flap carries a good arterial and nerve supply. This will be described.

Position.—Abduct the arm. The operator stands facing the palm and the assistant stands facing him.

Operation.—Make an U-shaped incision on the palmar surface commencing about half an inch below the styloid process of the radius, vertically downwards over the thenar eminence, to the middle of the metacarpal bone of the index finger. Angle it inwards and carry it across the palm at a level of the middle of the metacarpal bones in an arched fashion towards the ulnar margin of the hand, and then turn it upwards to a point half an inch below the styloid process of the ulna. The incision cuts the skin and the superficial fascia. Now, pronate the hand and connect the upper ends of the incision from styloid to styloid by a cut on·the dorsum of the hand. Deepen the palmar incision and dissect the flap up including the thenar and hypo-thenar eminences and other soft tissues down to the flexor tendons. Turn this flap upwards to the level of the wrist-joint. Turn again to the dorsum and dissect a small dorsal flap up to the joint line. Cut through the extensor tendons which are now exposed on the back of the wrist, at the level of the retracted skin. Now hold the hand in the pronated position. The assistant draws up the flap on the back. Open the joint commencing on the radial side, taking care not to injure the triangular fibro-cartilage connected to the ulna and the radio-ulnar articulation. The hand remains connected to the forearm only by the flexor tendons. These are severed by cutting boldly from above downwards. This completes the operation. (Fig. 38).

For *an elliptical incision* make the palmar flap longer and the dorsal flap with a definite convexity upwards.

For a *modified circular amputation*, two small flaps are made on the dorsal and palmar aspects about an inch below the level of the joint.

Durbueil's amputation is performed when all the soft tissues on the ulnar aspect of the arm are destroyed. There is no reason, however, why the whole or part of the thumb should not be saved if sufficient healthy soft tissues on the radial side of the palm can be obtained.

THE FOREARM.

A. AMPUTATION THROUGH THE LOWER THIRD OF THE FOREARM.

Instruments.—Group III.

Position.—Abduct the arm and stand on the outer side in the case of the right limb and on the inner side in the case of the left. Assistant stands on the left of the operator to steady the arm and retract flaps. For the lower third of the forearm, it should be amputated by the modified circular method and if possible below the insertion of the pronator radii teres. This gives a fairly good covering for the stump and the movements possible by the pronator radii teres muscle are not interfered with.

Operation.—Estimate on the skin the line of bone-section. The bone should be divided below the insertion of the pronator radii teres which corresponds to the middle of the shaft of the radius. Incision is made for an antero-posterior, modified circular flap, the lowest point of the transverse line of the incisions reaching one and half inches below the line of the future bone-section. Pronate the arm for the posterior incision and supinate it for the anterior one. The two incisions meet on the ulnar and radial sides of the forearm. Dissect up the flap with gentle touches of the knife. Retract the flaps and divide the muscles at the level of the retracted skin by a circular sweep of the knife. Enter the knife into the interosseous space and divide the interosseous membrane

transversely. Cut the periosteum on the saw line and raise
it with a periosteal elevator. Retract the muscles with the
periosteum. Saw through both bones at the same time,
holding the arm in supination. Allow the muscles to cover
the bones and appose the skin flap (Fig. 39).

Comment.—(1) Let . the periosteum cover each bone
completely, preventing union between the bones as this would
affect movement. (2) The radial, ulnar and the anterior and
posterior interosseous arteries will need ligature.

B. AMPUTATION THROUGH THE UPPER THIRD OF
THE FOREARM.

This can be performed by equal antero-posterior flaps or
by long anterior and short posterior flaps, and the flaps would
with advantage be skin-and-muscle flaps. The former will be
described.

Position.—Same as for the previous operation.

Operation.—The combined length of the flaps must be
one-third longer than the diameter of the limb at the point
of bone-section in order to make an allowance for skin retrac-
tion. Measure the antero-posterior diameter of the limb at
the point of bone-section between the finger and the thumb.
In the case of the right limb, for the anterior flap, the incision
is carried downwards through the skin and fascia along the
ulnar margin for about two inches or according to the
diameter of the limb, then transversely across the flexor
aspect to the radial margin. It is then carried upwards along
this margin for a similar distance. Thus an U-shaped
flap is marked out on the flexor aspect. The assistant
flexes the elbow presenting the extensor aspect to the
operator ; a similar U-shaped flap is now fashioned on that
aspect.

Supinate the arm. Raise a skin-and-fascia flap on the
anterior aspect for about half an inch ; and cut more and more
deeply into the muscles as the knife goes upwards till, by the
time it reaches the line of the bone-section, the flap has all

the soft tissues in it down to the bone. Change the position of the arm again and raise a similar flap from the posterior aspect. Clean the bone, raise the periosteum and make the saw cut as in the previous operation, the assistant having retracted the soft tissues.

Comment.—(1) The vessels to be secured are the same as in the previous operation. (2) For this and the previous operation a three-tailed gauze retractor will be found useful (Fig. 36).

THE ELBOW.

AMPUTATION OF THE FOREARM BY DISARTICULATION THROUGH THE ELBOW-JOINT.

Instruments.—Group III.

Several methods have to be recommended, *e.g.*, (1) Modified circular. (2) Elliptical. (3) Long internal and short external flaps. (4) A long anterior flap. The choice will depend upon personal preference or on the sound skin and soft tissues available for covering the stump.

Position.—The forearm is semiflexed and supinated. The operator stands on the inner side of the left limb and outer side of the right.

Operation.—The base of the large anterior flap should be longer than half the circumference of the limb and should be U-shaped. The anterior incision commences either an inch below the internal or an inch and a half below the external condyle of the humerus according to whether it is the right or the left elbow to be disarticulated. For the right limb, the incision is commenced at a point one inch below the internal condyle and is carried for about three and a half inches down to the ulnar border of the forearm. This forms the inner limb of the U. It is then carried along the flexor aspect of the forearm slightly curved downwards, representing the bend of the U to the radial side of the forearm, and then carried upwards (representing the outer limb of U) to a point an inch and a half below the external condyle. The skin and fascia

are raised for about an inch, then the knife goes deeper and deeper encroaching more and more on the underlying muscles till it is carried to the elbow-joint. This exposes the joint. Turning to the posterior aspect of the forearm, a posterior flap skin and fascia deep is raised from one extremity of the anterior flap to the other. This incision when deepened exposes the posterior aspect of the joint. These flaps are retracted by the assistant. The knife is inserted on the outer aspect of the joint and the external lateral ligament, the anterior and posterior ligaments and the internal lateral ligament are cut through ; the tendon of the triceps is detached from the olecranon process. This completes the disarticulation. The radial and the ulnar arteries are found on the anterior flap superficially, the interosseous artery more deeply. The superior profunda is in front of the external condyle and the inferior profunda behind the internal condyle (Fig. 39).

Comment.—(1) Open the joint from the outer side as the radio-humeral joint is more easily found. (2) The internal condyle is on a lower level than the external condyle.

THE ARM.

AMPUTATION OF THE UPPER ARM.

Position.—Dorsal position, near the edge of the table. The arm is generally in an abducted position but it may have to be held vertically or down across the chest during the different stages of the operation.

Two methods of amputation are known :—

1. By antero-posterior flap.—In this method there is a risk of splitting the brachial artery while making the inner vertical incision ; besides it has no special advantage over the following method.

2. Modified circular method.—(Fig. 39).

Operation.—The skin incision for the flap is made according to the rules for modified circular flap. The skin-flap

having been raised, the muscles are divided by the following method :—

Hold the amputating knife in the usual way. Divide the superficial layer of muscles including the biceps and the triceps at a little lower level to allow for their retraction. Divide the deep muscles at a slightly higher level down to the bone. The periosteum is elevated in the usual way and the bone sawn through well up the level of the base of the skin-flap.

The following vessels are seen divided :—The brachial on the inner side with the median nerve, the superior profunda on the postero-external aspect with the musculo-spiral nerve, inferior profunda on the inner side of the brachial with the ulnar nerve. Some muscular branches are also seen.

Comment.—(1 The biceps and triceps retract much more than the deeper muscles, so if they are cut on a lower level they will help in covering the bone stump. (2) The musculo-spiral nerve in its groove in the humerus should be freed from the bone and cut short, otherwise it will be caught in the callus of the stump and give rise to severe pain and perhaps eventually to neuritis. (3) Whenever possible amputate below the middle of the arm, below the insertion of the deltoid and the pectoralis major. These will contribute greatly to the after-movement of the stump and therefore better facilities for an artificial limb.

THE SHOULDER-JOINT.

DISARTICULATION OF THE SHOULDER-JOINT.

Surgical anatomy.—The following anatomical points should be noted. The spine of the scapula terminates in the acromian process which overhangs the joint. Exactly below this as the arm hangs by the side of the body is the greater tuberosity of humerus. A little below this and more towards the front of the joint is the lesser tuberosity. The greater tuberosity faces in the same direction as the external condyle. Between the tuberosities is the bicipital groove in front of the joint. Near the groove, a little below the clavicle is the

coracoid process of the scapula. The anterior fold of the axilla is formed by the pectoralis major and the posterior fold by the latissimus dorsi and subscapularis.

There are numerous methods of removing the arm. Among them are :—(1) By external and internal flaps. (2) By external or deltoid flap. (3) By antero-posterior flaps. (4) By Furneaux Jordan's method, *viz.*, a preliminary circular high amputation of the arm and then a final disarticulation, and (5) by Spence's racket method.

Hæmorrhage can be controlled by one of the following methods :—(*i*) Digital or instrumental compression of the subclavian ; (*ii*) preliminary high ligation of the axillary ; (*iii*) ligation of the subclavian artery ; (*iv*) compression by Esmarch's cord and (*v*) digital compression of the axillary in the flap before it is cut.

Spence's racket method has advantages over other methods of disarticulation and will be described. In this method hæmorrhage can be controlled either by preliminary ligature of the vessels or by the assistant compressing them with the soft tissues in the posterior aspect.

Position.—The arm is held abducted and slightly rotated externally.

Operation (Spence's method).—1. The axillary vessels may be secured between two ligatures in its third part as a preliminary measure.

2. An incision is commenced on the outer side of the coracoid process and carried vertically downwards cutting through all the soft tissues down to the neck and shaft of the humerus as far as the lower limit of the anterior fold of the axilla. This incision divides the anterior fibres of the deltoid and the insertion of the pectoralis major.

3. The incision is carried outwards dividing all the structures down to the bone as far as the back of the arm.

4. An incision, skin deep, is made from the lower end of the vertical cut round the inner side of the arm to join the deep outer incision (Fig. 41).

5. The large external flap with the deltoid and the posterior circumflex artery entering into its deep surface, is raised by the hand from the bone and the joint. It is retracted by gauze or broad metal retractors.

6. The muscles attached to the tuberosities are divided by cutting directly down to the bone. The capsular muscles, the capsule and the long head of the biceps are divided. The head of the humerus is rotated inwards or outwards in order to facilitate this.

7. The head is then pushed out of the glenoid cavity and the posterior flap is dealt with as follows :—(a) if the artery has already been ligatured, the soft tissues are cut across about the level of the posterior skin incision ; (b) if the vessels have not been previously ligatured, the assistant holds the soft tissues on the axillary aspect between his thumb and palm from either side, compressing the vessels. The soft tissues are now cut across below the assistant's hands and the vessels secured. The nerves are cut short. The disarticulation is now complete.

Comment.—(1) More than one assistant is necessary for this operation. (2) Digital or instrumental compression of the subclavian is not always satisfactory. (3) Controlling hæmorrhage by crossing an elastic tubing under the axilla and fixing it above the shoulder is not reliable ; it may slip at a critical moment. (4) The best methods are those already described, namely, preliminary ligature of the vessels or controlling it by the thumb and the hand in the posterior flap. (5) The axillary artery is divided between the origin of the posterior circumflex and superior profunda. The vertical incision may cut the humeral branch of the acromio-thoracic artery and deeper down the anterior circumflex.

CHAPTER VIII.

AMPUTATIONS OF THE LOWER EXTREMITY.
THE TOES.

THE weight of the body is chiefly supported on the heel behind, and on the heads of the metatarsal bones in front. The inner side of the foot being the main support, the heads of the metacarpal bones and the whole of the great toe should be saved whenever possible ; the outer four digits do not have a similar importance.

Instruments.—Group III.

Position.—The foot should be brought well beyond the end of the table. The operator stands at the end of the table, facing the foot, and the assistant stands facing him.

A. The terminal phalanx.

Amputation by disarticulation of the terminal phalanges of the toes.

These amputations are done by the same method as for the fingers ; a long plantar flap corresponding to the long palmar flap.

Amputation of the terminal phalanx of the great toe.

Operation.—Hold the toe between the thumb and the first two fingers of the left hand. Make an incision down to the bone, commencing from the joint line along the inner (tibial) side of the terminal phalanx nearer the dorsal than the plantar aspect. This is continued across the tip of the toe beneath the free margin of the nail, along the outer (fibular) aspect, as far as the joint line. The plantar flap is thus marked out. Deepen the incision and dissect the flap up from

the bone. The joint is opened on the plantar aspect. Flex the terminal phalanx. Make the dorsal incision from the upper extremities of the lateral incisions on the dorsal aspect of the joint. This incision divides the extensor tendon and opens the joint. The internal and external lateral ligaments are cut, the toe being rotated outwards and inwards while doing this. The cicatrix lies on the dorsum.

Comment.—(1) The two small dorsal digital arteries will be seen at the corners of the dorsal incision. (2) The two plantar digital arteries should lie buried in the flap and should not be cut if the knife is kept close to the bone.

B. The second phalanx.

Amputation or disarticulation of the second phalanx. The method corresponds to similar disarticulation of the second phalanx of finger.

Comment.—(1) In this disarticulation either remove the head of the first phalanx or amputate through this bone on a level with the head, as the large head of the first phalanx will act like a foreign body, as the muscles of the sole of the foot are mostly inserted at its base. (2) Use a fine metatarsal saw for dividing the bone and do not try to cut the bone with bone-cutting forceps as this is liable to crush the bone. (3) The two dorsal and the two plantar digital arteries will be cut.

C. Metatarso-phalangeal joint.

Amputation at the metatarso-phalangeal joint.

(*a*) Amputation of the great toe by disarticulation of the metatarso-phalangeal joint (Fig. 42). This is performed by the racket incision with unequal limbs. The head of the metatarsal bone is of large size, and sufficient flap must be kept on the inner aspect to cover it.

Operation.—Commence an incision three-fourths of an inch behind the joint on the inner side of the extensor tendon and extend it forwards over the joint and then let it bifurcate.

The outer limb of the incision crosses transversely on the dorsum towards the second phalanx and from thence round to the plantar aspect. . The inner limb is practically a continuation of the first vertical incision. It is brought forward along the inner aspect of this first phalanx to the proximal side of the inter-phalangeal joint to meet the inner limb on the plantar aspect. Dissect the flaps up. Locate the joint exactly by rotating the toe in different directions. Open the capsule from the plantar aspect preserving the sesamoid bone.

Comment.—(1) The external plantar digital artery is cut close to the web, the internal at the free end of the inner flap. The dorsal digital vessels will also be seen. 2· Remember that the large size of the head should be well covered with plantar skin as it has to bear the weight of the body. ·3 The sesamoid bones should be preserved ; they are situated under the head and in the tendon of the flexor brevis pollicis. (4) Try to preserve the base of the first phalanx whenever possible as it has many of the muscles of the sole inserted into it and thus strengthens the sole of the foot. (5) The line of the joint is sometimes difficult to find, even after raising the flap. Movement of the toes by rotation, flexion and extension will help to determine its position. While cutting into the joint keep the blade of the knife close to the base of the phalanx.

(*b*) Disarticulation of the little toe at the metatarsophalangeal joint. This is also performed by racket incision with unequal limbs.

Operation.—An incision about half an inch long is made from behind the dorsal and outer aspect of the head of the fifth metatarsal bone, to the line of the joint. Another incision is made from the termination of the first incision transversely towards the fourth toe. The first incision is carried along the outer side of the little toe as far as the interphalangeal joint, and then round the toe to the plantar aspect, to complete the racket. In this case, as in the case of great toe, one⁓ limb· of the racket passes almost

transversely across the toe, while the other (the outer in the case of the little toe, the inner in the case of the great toe) is carried forwards for some distance in continuation of the vertical incision, before encircling the plantar aspect of the toe. The amputation is completed in the usual manner, the joint being opened from the outer side.

Comment.—In forming the flaps in all amputations of the toes, consideration must be given to the fact that the head of the metatarsal bones are large and require more soft tissues to cover them than a cursory examination would lead the operator to suppose.

(c) Amputation of other toes. The operation resembles very closely amputation through the corresponding joint of the finger.

Comment.—(1 The joint lines are further back than in the case of the hand. (2) Always see that the cicatrix comes on the dorsal aspect ; it should not be on the sole where it has to bear the weight of the body.

THE METATARSALS.

(a) Disarticulation of the great toe with the metatarsal bones. The operation is exactly similar to that for removing the whole of the great toe (through the metatarso-phalangeal joint) except that the incision on the dorsum commences at the base of the metatarsal bone.

(b) Disarticulation of the little toe with the metatarsal bone is performed on the same lines as the previous operation, the outer flap being kept longer than the inner.

THE FOOT.

Amputations through the various joints of the foot. The following operations are generally performed :—

A. Lisfranc's—through the tarso-metatarsal joint.

B Chopart's—through the mid-tarsal joint.

    C.   Faraboeuf's—sub-astragaloid amputation.

    D.   Syme's—through the ankle-joint.

    E.   Pirogoff's—intra-calcaneal amputation.

Lisfranc's and Chopart's disarticulations have but little claim for mention in a surgical work. Practically no disease or injury would indicate these operations. Sawing through a bone is not considered now any more dangerous than disarticulation of a joint, the latter is oftentimes the more complicated of the two. Cheyne and Burghard remark that the clinical indications for operations such as the disarticulation of the anterior part of the foot at the tarso-metatarsal joints are practically none. If for instance, the foot be the seat of a sarcoma it needs a high amputation. If, on the other hand, the foot has been severely crushed or otherwise injured, a plantar flap long enough to cover the stump will hardly be available. Again, the anatomical arrangements of the joints and their synovial membranes are such that in septic infections or in tubercular disease, Lisfranc's or Chopart's amputation will hardly extirpate the disease. Chopart's amputation has an additional objection ; the tendo Achillis inserted into the back of the os calcis pulls on that bone and tilts its front downwards so that it forms a conical stump and the weight of the body is thrown on the anterior articular surface of that bone. Syme's disarticulation at the ankle-joint or its modifications have met with some surgeons' approval. The sub-astragaloid amputation leaves the ankle-joint intact and is an operation of some merit.

Instruments.—Group III.

A. Lisfranc's disarticulation through the tarso metatarsal joint.

Position.—The foot projects well beyond the end of the table. The opposite limb is tied or held out of the way by assistant. The operator stands facing the sole of the foot.

Surgical anatomy.—Note two bony landmarks, the tip of the base of the fifth metatarsal bone on the outer side and the tuberosity of the scaphoid on the inner side. Put the

forefinger and thumb of the left hand on these landmarks, the
palm of the hand being on the sole. Hold the foot in full,
extension.

Operation.—An incision is made across the dorsum of,
the foot, joining a point one inch in front of the tuberosity.
of the scaphoid, to the base of the fifth metatarsal bone, and
curving in such a way that it is convex towards the toes.
This incision divides all the soft structures including the tendons
down to the bone. Now, flex the foot and map out a plantar
flap by an incision made on the outer side of the foot, starting
from the termination of the dorsal incision on that side ; it
is then carried forwards along the under-surface of the fifth
metatarsal bone until it reaches a point half an inch behind
the metatarso-phalangeal joint. Crossing the sole of the foot
at the level of the heads of metatarsal bones, and sloping
slightly towards the toes, the incision reaches the inner side
of the first metatarso-phalangeal joint, whence it is carried
back along the inner side of the foot to join the extremity
of the original dorsal incision, an inch in front of the tuberosity
of the scaphoid bone. The flap thus mapped out is raised by
a knife, keeping its edge as close to the bone as possible. The
joints are to be opened from the outer aspect. Commencing
at the base of the fifth metatarsal bone, the edge of the knife
is inserted behind the tuberosity of that bone and carried
forwards for about one-fourth of an inch. The blade is now
introduced into the joint, between the fifth metatarsal bone
and the cuboid, and then working from without inwards the
two succeeding tarso-metatarsal joints are opened. The three
articulations, *i.e.*, the fifth, the fourth, and third tarso-meta-
tarsal joints, are almost in a straight line. After division of
these three joints the blade of the knife meets a bony obstruction
formed by the base of the second metatarsal bone which
projects further backwards than the bases of the other
metatarsal bones. The knife is withdrawn and inserted between
the metatarsal of the great toe and internal cuneiform bone
on the inner side, disarticulating this joint. The second

tarso-metatarsal joint is now disarticulated. The foot is over-extended and the ligamentous band (Lisfranc's ligament) which binds the base of the second metatarsal and the internal cuneiform bones is cut. The plantar flap is turned over the stump. The cicatrix lies over the dorsum (Fig. 40).

B. Chopart's amputation through the mid-tarsal joints.

Position.—As in Lisfranc's operation.

Operation.—The forefinger and thumb are placed behind the spur on the base of the fifth metatarsal bone and behind the scaphoid tuberosity. These two points are joined on the dorsum by an incision curving downwards, towards the toes, cutting through all structures down to the bone. A plantar incision is made commencing from the outer extremity of the dorsal incision and carried to the middle of the shaft of the fifth metatarsal bone. It is then carried across the sole of the foot in an arched manner (convexity towards the toes) and finally backwards along the inner aspect of the foot, to reach the inner extremity of the dorsal incision. This incision is deepened to the bone. The plantar flap is dissected up, keeping the knife close to the bone. The joint is opened from the inner side, behind the tuberosity of the scaphoid, disarticulating it from the astragalus. The knife is now carried across to the outer side of the foot through the joint between the cuboid and the os calcis.

Comment.—(1) Dorsalis pedis artery is cut in the dorsal flap. Near the inner part of the plantar flap the internal plantar artery is cut and near the base of the second metatarsal, the external plantar. Digital branches and metatarsal and tarsal branches are also cut. (2) When entering the knife into the inner side of the joint, take care to see that it is not entered in front of the scaphoid, *i.e.*, between the scaphoid and the internal cuneiform bones.

C. Subastragaloid disarticulation of the foot (Faraboeuf).

In this operation the whole of the foot is removed excepting the astragalus, leaving the ankle-joint intact.

Position.—Place leg on its inner side ; foot projects beyond the table. Stand facing the foot.

Operation.—A modified racket incision is the most convenient. It is commenced at the outer part of the tuberosity of the os calcis at the insertion of the tendo Achillis ; the incision is then carried along the outer margin of the foot, about half an inch below the external malleolus, until a point just behind the spur on the base of the fifth metatarsal bone is reached. A curved incision is next carried across the dorsum of the foot, with the convexity towards the toes. This incision should reach the inner side of the foot at the level of the first metatarso-phalangeal joint ; it then traverses the sole to reach the starting-point of the incision at the tubercle of the os calcis. These incisions involve the skin and fascia only. When the skin has retracted, a second incision is made along the same route dividing all the structures down to the bone.

The tendo Achillis is divided at the starting-point of the incision, and the flap on the dorsum of the foot separated from the underlying bones. The posterior aspect of the joint between the astragalus and os calcis is opened, and the knife brought forward from this position in order to divide the interosseous ligaments which bind the astragalus and the os calcis. With the foot twisted outwards, the soft tissues on the inner and inferior aspects of the os calcis can be freed and the disarticulation completed.

Comment.—In the outer part of the flap are the anterior and the posterior peroneals and branches of the tarsal and metatarsal arteries. In the inner part are the dorsalis pedis and tarsal arteries. In the inner part of the dorsum and the sole are the internal and external plantars.

D. Syme's disarticulation of the foot at the ankle-joint.

This is a good operation for tubercular disease of the tarsus or for crushed injuries of the anterior part of the foot where a heel-flap can be obtained.

Position.—Leg rests on a block and foot projects beyond the table ; operator sits facing the foot, assistant stands opposite and steadies the leg.

Operation.—Two bony landmarks are felt for, *viz.*, the internal and external malleoli. There are four stages of the operation :—(1) Raising the heel-flap : (2) The dorsal incision : (3) The disarticulation, and (4) the removal of the malleoli.

(i) *The heel-flap.* Hold the ankle with the left hand and make the stirrup incision as follows :—Enter the knife just below the tip of the internal malleolus and carry it vertically down to the margin of the heel ; then carry it transversely across the sole to the opposite margin of the heel ; next carry it vertically upwards along the inner side of the ankle to a point half an inch below the tip of the inner malleolus. This stirrup incision, throughout its length, is made deep down to the bone and marks the line of the heel-flap ; an excision knife will be useful.

Pull the heel-flap up from the bone by the thumb and forefinger covered with gauze and raise it with touches of the knife, its point strictly directed towards the bone. Dissect the flap first from the tuberosity of the os calcis and then from its posterior surface.

(ii) *The dorsal incision.* Hold the foot in full extension. The upper ends of the stirrup incision are joined across the dorsum in front of the joint by the shortest route ; this incision divides all the tissues down to the bone. The ends of the dorsal and stirrup incisions meet at right angles.

(iii) *The disarticulation.* Cut through the anterior annular ligament, the joint is thereby exposed. Introduce the knife into the joint and divide the lateral ligaments cutting from within outwards. Cut the posterior ligament, clear the upper surface of the os calcis and divide the tendo Achillis. This completes the disarticulation.

(iv) *The removal of the malleoli.* Clear the two malleoli on the lower end of the tibia of all soft structures by the knife

and periosteal elevator. Apply the saw a quarter of an inch above the inferior margin of the tibia and cut through the exposed bone horizontally. The flaps can now be brought together (Fig. 43).

Comment.—1. The following vessels have to be secured:—The anterior tibial artery in the dorsal flap at about its middle ; the external and internal plantar arteries in the inner section of the heel-flap, the internal malleolar of the posterior tibial behind the inner malleolus ; the anterior peroneal in front of the tibio-fibular joint ; the external and internal malleolars of the anterior tibial in front of their corresponding malleoli ; the internal saphenous vein in the dorsal flap, the external in the heel-flap. 2. The inner vertical limb of the stirrup incision is better cut from above downwards commencing half an inch below the tip of the heel incision. 3. While raising the heel-flap do not button-hole the flap. The knife should be rigidly kept close to the bone and in raising the flap with the thumb the periosteum can be taken up from the os calcis. 4. In cutting the flap with the stirrup incision from the tip of the inner malleolus do not go behind the tip, as the posterior tibial artery may be divided before its bifurcation and by this the internal calcaneal branch of the external plantar which is the main artery of the flap may be lost.

A modification of Syme's amputation.

Instead of dissecting up the heel-flap from below, as described in the previous operation, and opening the joint at a later stage, it is thought more convenient by some to open the ankle-joint freely (after the incisions are made) through the anterior incision by dividing the ligaments and dislocating the astragalus forward, so as to expose the superior non-articular surface of the os calcis. The tendo Achillis is severed, and still working from the dorsal aspect, all the lateral and inferior attachments of the soft tissues to the os calcis are separated from that bone by rapid strokes of the knife. The foot can now be removed, and the operation completed.

Syme's amputation can be very readily performed by this method, but great care is necessary not to injure the heel-flap when separating it from the posterior aspect of the os calcis.

E. Pirogoff's intra-calcaneal amputation of the foot.

This operation resembles Syme's with the exception that the os calcis is sawn through and its posterior part left in the heel-flap. The lower ends of the tibia and fibula are sawn through and the sawn surface of the os calcis is brought into apposition with it (*i.e.*, with the sawn surface of the tibia and fibula).

THE LEG.

AMPUTATIONS OF THE LEG.

The leg may be amputated in three regions :—
1. Supra-malleolar amputation.
2. Amputation through the middle of the leg.
3. Amputation at the seat of election.

Of these three, the supra-malleolar amputation by Teal's or any other method or amputation through the middle of the leg, has no special advantage over amputation at the place of election. The first two amputations can however be performed by osteoplastic or tendinoplastic methods, and useful artificial limbs made for the stumps as have been proved by the recent war. Amputation at the place of election gives uniformly good results and has other points to recommend it. This is going to be described.

Faraboeuf's amputation of the leg (at the seat of election).

The bone-section goes through tibia and fibula about a hand's breadth below the knee-joint, a little above the great nutrient foramen of the tibia or at a lower level (Fig. 45).

Position.—The knee-joint projects beyond the end of the table. The other leg is held out of the way. For the

right leg, stand on the outer side of the limb, for the left, at the end of the table, for the skin incision. For the rest of the operation, the operator has to change his position as necessary. The assistant standing at the end of the table *manipulates the leg in such a way that its inner or outer side* is presented to the operator as required for different stages of operation. A second assistant will be useful for supporting the thigh and retracting the soft tissues. The knee is flexed.

Operation.—The flap is to be taken from the outer side of the leg where sufficient muscular tissue to cover the bones is available. Take the circumference of the leg at the level of bone-section ; take a measure one-third of this circumference. The large external flap is U-shaped consisting of two limbs, anterior and posterior, the lower ends of these limbs being joined by a line slightly curved downwards. The length of this flap equals a third of the circumference which has already been measured.

1. The anterior limb of the U-incision commences opposite the line of bone-section, and is carried down the leg slightly on the inner side and parallel with the anterior crest of the tibia. The posterior limb of the U commences on the calf, about half an inch below the corresponding point of the anterior limb. It is carried vertically downwards till its lower end is on a level with the lower end of the anterior limb. These two lower points are joined by a transverse incision slightly sloping downwards. Free the skin along the edge of whole length of the incision and allow it to retract.

2. Turn the limb outwards. Draw the knife across the inner side of the leg from the upper end of the posterior incision to a point on the anterior cut, half an inch below its upper end. The incision is only skin deep. Free the skin slightly along this incision.

3. Turn the limb with its inner surface downwards. After the skin of the great U-flap has been undercut for about half an inch all round the flap, the external flap is raised in the

following manner. Insert a dissector or your fingers between the outer side of the crest of the tibia and the tibialis anticus and separate it from the bone up to the lower limit of the flap. Turning to the lower margin of the flap, raise the muscle-and-skin flap by cutting the muscles obliquely, so that it is thin at the lower part and gets thicker at the upper part. Raise the muscles from the two bones and the interosseous membrane and, in doing so, do not raise this flap up too high, where the anterior tibial artery pierces the interosseous membrane, as it may then be accidentally divided.

4. Turn to the smaller, inner flap and cut across the soft tissues on a level with the retracted skin. Retract the soft tissues by a three-tailed gauze retractor (Fig. 36).

5. Sawing of the bones. Divide the interosseous membrane in the line of the bone-section. Raise the periosteum from the bones to a point just above the saw line. Stand to the outer side of the right leg and to the inner side of the left. Saw the fibula first in a direction from above downwards and

Method of sawing the tibia.

Method of sawing the bones of the leg.
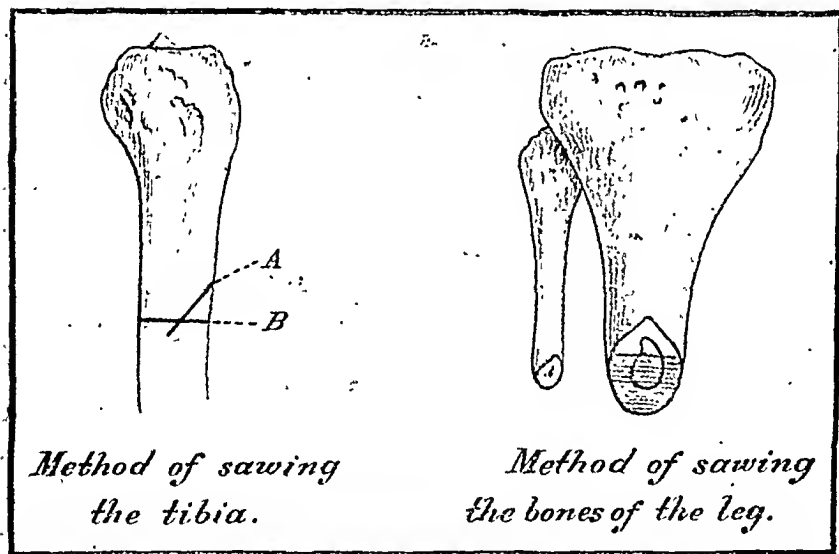
Fig. 44.   Fig. 45.

Amputation at the seat of election.

PLATE XIII.
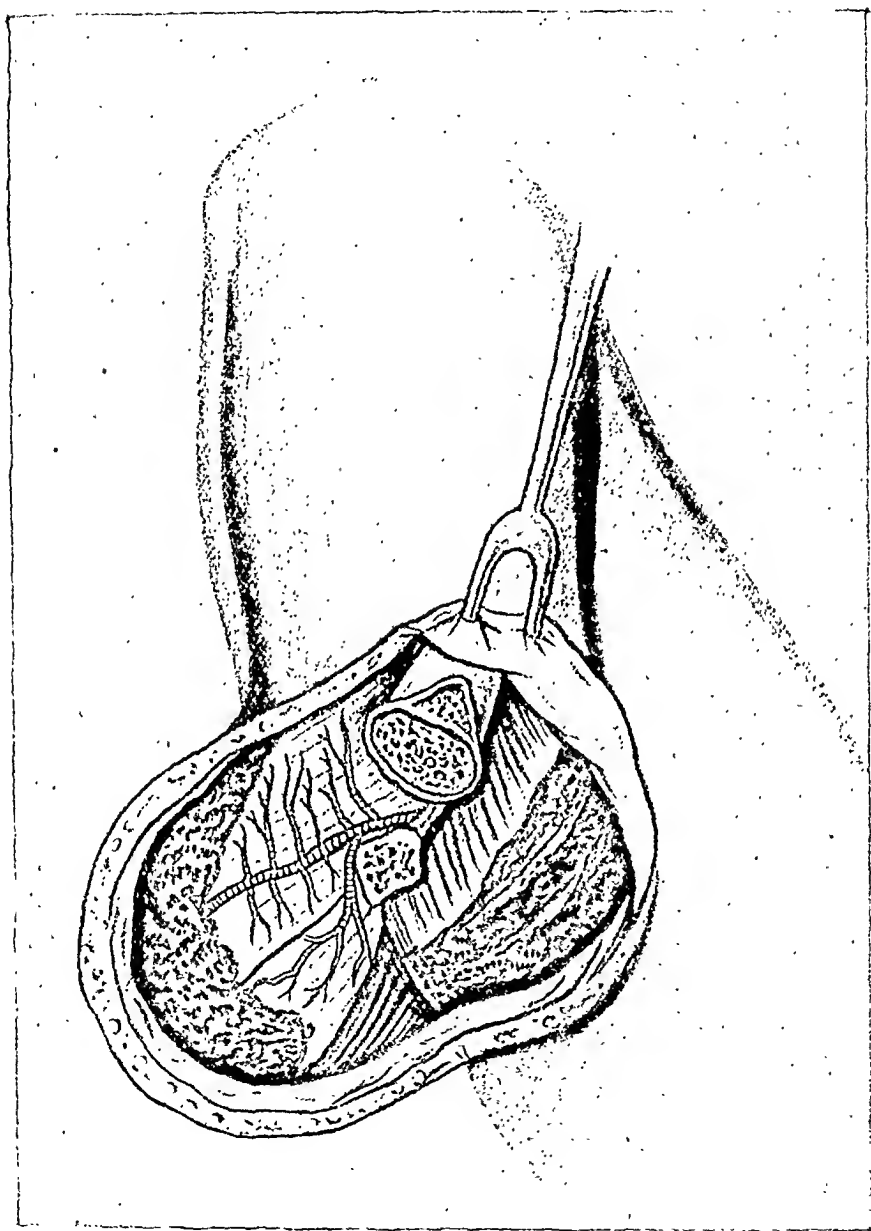
FIG. 46.

Amputation at the seat of election (Faraboeuf).

inwards at a slightly higher level than the line of section of the tibia. Hold the saw in such a way that its point be directed towards the floor in the case of left limb and towards the ceiling in the case of the right. In sawing the tibia it is necessary to make the anterior part of the sawn tibia smooth by applying the saw an inch or more above the intended line of amputation, and dividing the crest obliquely from above downwards and backwards until the level for the transverse division of the bone is reached (Fig. 44). The saw is then removed and applied transversely; with a few strokes a small wedge-shaped portion of the sharp crest is completely divided from the rest of the tibia, and then the section of that bone is completed (Fig. 45). The coverings of the stump will rest on a smooth surface instead of a sharp crest, if the latter be removed in the manner just described (Fig. 46).

Comment.—(1) The following vessels have to be ligatured. The anterior tibial artery is divided at the free margin of the internal flap. The posterior tibial and peroneal vessels lie close together on the inner flap. The muscular branches to gastrocnemius and soleus are also cut. The nutrient artery of the tibia will be divided as it enters the bone. If the great muscles in the outer flap are raised too high up, the anterior tibial artery will be in danger of being divided, as it pierces the interosseous membrane; the vitality of the flap depends upon the integrity of this artery. (2) Some surgeons recommend division of the two bones with one sawing, on the strength of the fact that it gives less chance of the fibula being split.

THE KNEE-JOINT.

AMPUTATIONS IN THE REGION OF THE KNEE-JOINT.

Amputations through the knee-joint give rather good stumps, because the broad lower end of the femur is well adapted to pressure and the surrounding skin is strong and dense.

The following methods of amputations in this region are known :—

A. Stephen Smith's disarticulation by lateral flaps.

B. Carden's trans-condyloid amputation through the condyles of the femur, by long anterior flap and removal of the patella.

C. Gritti's amputation through the condyles of the femur by long anterior flap with removal of the articular surface of the patella and apposing it to the sawn surface of the femur.

D. Stokes' supra-condylar amputation by long anterior flap, the patella being treated as in Gritti's method.

A. Stephen Smith's disarticulation of the knee-joint by lateral flaps.

The two lateral flaps consist of integuments only, the internal flap being slightly longer than the external. The soft structures behind the knee are divided transversely about the level of the articulation. The operation can be performed with great rapidity.

Position.—Pull the leg down, beyond the end of the table, till the knee is quite beyond the edge. Stand to the outer side. The assistant holds the leg and rotates it as required.

Operation.—Mark out two points with the thumb and a finger of the left hand—(*a*) the middle point of the popliteal space behind, opposite the line of the joint, and (*b*) a point about two inches below the tubercle of the tibia in front. The operation can be described in four stages.

1. *The skin incision.* Bend over the limb which is rolled outwards. Commence an incision in the middle of the popliteal space, carry it obliquely downwards, inwards and forwards to a point at the junction of the upper with the middle-third of the tibia. When it approaches the crest of the tibia, curve it upwards to end at a point two inches below its tubercle. This marks out the outline of the inner flap. Now the assistant lifts the leg up vertically. Commence another incision below

the tubercle of the tibia where the former incision ends. Carry it downwards, backwards and then upwards on the back of the leg to meet the original incision in the popliteal space. This marks out the outline of the outer flap. The lower point of this incision is on a slightly higher level than that of the inner. These incisions divide the skin and superficial fascia only.

2. *The skin-flaps*. Free the margin all round and raise this flap, which includes skin and the soft structures, down to the tendons and muscles. Cut the ligamentum patellæ close to the tuberosity. This exposes the front of the head of the tibia, the tendons and muscles. Retract the flap up to the level of the joint-line.

3. *The disarticulation*. Cut the lateral ligaments and the anterior parts of the capsule of the joint. Enter the knife between the interarticular fibro-cartilage and the head of the tibia cutting through all the soft structures. Flex the knee and divide the crucial ligaments close to the tibia as they meet the knife.

4. *The posterior aspect*. Divide all structures by a transverse cut on this aspect of the leg, which include the posterior ligament, the popliteal vessels, muscles and tendons.

Comment.—(1) The following vessels have to be secured. The popliteal artery and veins are the vessels of importance ; the muscular arteries, the azygos artery, branches of the superior articular vessels (on the outer side) and the superficial division of the anastomotica magna (on the inner side). (2) The internal flap is longer than the external in order to provide a good covering for the internal condyle, which is larger and on a lower level than the external. The skin-flaps, after amputation on the dead subject, may look disproportionately long and rather thin ; this is, however, not so when the operation is performed on the living. The drainage is efficient from between the flaps as the wound looks directly downwards when the patient lies in bed. (3) The

scar lies well behind and between the condyles. (4) The semilunar cartilages left under the condyles form a natural cushion for the stump.

B. Trans-condyloid amputation. (Carden.)

In Carden's original operation, the femur is divided through the condyle and the patella is removed. A long anterior flap is made by an incision commencing from one condyle and extending vertically downwards for about four inches, carrying across the front of the tibia, a little below the level of the tubercle, and then upwards to the opposite condyles. A small posterior flap is made by a sweep of the knife through the skin and superficial fascia across the back of the knee-joint. The long anterior flap, occasionally, sloughs due to want of vascular supply. Lister modified this operation by cutting transversely across the front of the limb from side to side at a level of the tuberosity of the tibia, and joining the horns of this incision posteriorly, by carrying the knife at an angle of 45 degrees to the axis of leg through the skin and fat. The flap consisting of skin and subcutaneous tissue are raised as in circular amputation. The soft tissues are cut transversely across. The periosteum covering condyles and the femur is divided and a saw applied not at right angles to the bone, but at a slight angle so as to cut a little lower on the inner side, thus maintaining the normal obliquity of the condyles. The patella is generally removed with the tendon of quadriceps extensor. The muscles can be brought together over the bony stump by a few sutures.

C. & D. Supra-condyloid amputation. (Stokes-Gritti method.)

In this amputation the flaps are made as in Carden's operation, i.e., by long anterior and short posterior flaps. The ligamentum patella is divided and the anterior flap, including the patella, is turned up. The condyles of the femur are cleared and a portion of the lower end of the femur is removed. In Gritti's amputation the saw traverses the bone

Amputations in the region of the knee-joint.

Methods.	Operation.	Flaps.	Line of bone-section.	Advantages.	Disadvantages.
I. Stephen Smith's.	Disarticulation.	Lateral	Between semilunar cartilages and head of tibia : no bone-section.	(1) Scar in intercondyloid space where no pressure. (2) Semilunar cartilages act as cushions. (3) Internal flap forms a good covering. (4) Quick operation. (5) Less shock. (6) Broad-ended stump. (7) Useful for labouring classes.	(1) False joint of artificial limb at a lower level. (2) Unsuitable from an aesthetic point of view.
II. Carden's.	Trans-condyloid amputation.	Long anterior, short posterior.	Transversely, through condyles, with removal of patella.	(1) Suitable for artificial limbs. (2) Broader base than Stokes'. (3) Posterior scar.	(1) Flap liable to slough due to bad vascular supply. (2) Patella is not utilised for stump.
III. Lister's modification of Carden's.	Do.	Modified circular	Obliquely through the condyles : removal of patella.	(1) Muscles made to cover the stump. (2) Normal obliquity of condyles maintained. (3) Scar anteriorly and not over stump.	Patella is not utilised.
IV. Gritti's.	Supra-condyloid	Long anterior, short posterior.	Trans-condyloid plane : articular surfaces of patella removed.	(1) Broad base of stump. (2) Patella utilised. (3) Scar posteriorly and not over stump.	(1) Defective apposition of patella and femur. (2) Patella may rest on anterior surface of femur. (3) Defective blood supply of anterior flap.
V. Stokes'.	Do.	Do.	Supra-condyloid plane (above condyles but through cancellous tissue) and articular surface of patella removed.	Better apposition of patella and femur.	Narrow base of stump.

in a trans-condylar plane, whereas in Stokes' operation it is carried at a higher level. With a small butcher's or a metacarpal saw the articular surface of the patella is removed. The anterior flap is now turned over to meet the posterior flap, and while doing so the sawn surface of the patella is apposed to a similar surface of the divided femur. In Gritti's method the femur is divided at a lower level, so the cut surface is broader and it is often difficult to appose the patella resting on the anterior surface of femur ; besides, there is a disproportion between the sawn surfaces of two bones. In Stokes' operation the femur is divided higher up and the sawn surfaces of the bone can be more accurately apposed.

THE THIGH.

AMPUTATIONS OF THE THIGH.

Amputations through the thigh should be performed as near its lower-third as possible, because in this position it is better suited for an artificial limb, and being further removed from the trunk, it gives less shock to the patient.

Circular amputations or its modifications are not suitable for the thigh, because the muscles on its inner and posterior aspects retract considerably and there is the risk of a conical stump. The operation of choice, therefore, is amputation by anterior and posterior flaps, the anterior flap being the larger of the two. The femoral artery should, as far as possible, be left in the small posterior flap, in order to avoid its being twisted round the end of the bone, as it would be if it was left in the larger anterior flap. The anterior flap would with advantage be made an antero-external flap, and the posterior, postero-internal. This is done in order to leave the inner vertical limb outside the line of the artery and avoid its accidental splitting, while making the inner vertical incision and leaving the artery too close to the margin of a flap. The length of the anterior flap should exceed the antero-posterior diameter of the limb at the line of bone-section. This is necessary for the retraction of the skin and muscles.

Amputation of the thigh by large anterior flap.

Position.—The limb is pulled down the table so that the body rests by its buttocks on the edge of the table. The other leg is kept out of the way. The operator stands on the right -side of the limb in case of either leg. One assistant supports the leg behind him and another stands in front of him to retract flaps.

Operation.—A large U-shaped flap is marked out on the anterior surface of the limb. The length of the flap should ·exceed the diameter of the thigh at the future bone-section. The lower end of this incision could, if necessary, extend down over the patella. Commence the incision at the inner or outer side of the thigh at the level of the bone-section, and carry it vertically downwards for a distance, at least, equal in length to the antero-posterior diameter of the thigh, then horizontally across the front of the thigh to a corresponding point on the opposite side. For the other vertical limb of the U, carry the incision upwards from this point until the two limbs are of ·equal length. The whole of this incision is skin and fascia ·deep. Now mark out the posterior flap by carrying the knife across the back of the limb, cutting through the skin and fascia at a distance below the upper limits of the skin incision, so that the length of this flap is one-third of the anterior flap.

Now raise the anterior flap. Begin by dissecting up the skin and fascia alone for about an inch all round the incision. The knife then cuts deeper and deeper through the muscles in a sloping manner till, by the time it reaches the base of this flap, it has cut through all the muscles and reached the bone. The base of this flap corresponds with the level for the future line of bone-section. The posterior flap is fashioned similarly by cutting in a sloping manner. Raise sufficient periosteal flap to cover the divided bone. One assistant now retracts the flaps by a double-tailed gauze retractor or metal retractors, and the other holds the leg steadily in the horizontal position, and the femur is sawn through. Some surgeons recommend

cutting the posterior flap by transfixion, but the method described above is one of greater precision.

Comment.—(1) The main vessels to be ligatured are in the posterior flap in low amputations, but they are in the anterior flap at or above the middle of the thigh. (2) The question of avoiding the splitting of the vessels by making the flaps antero-external and postero-internal has been discussed.

THE HIP-JOINT.

Amputation through the hip-joint by disarticulation.

Disarticulation of the hip is attended with much shock, and should not be performed unless the measure is justified by the urgency of its indications. Several methods have been devised by surgeons in order to perform this operation expeditiously and with the least amount of shock. Some of these methods are :—

1. External racket incision—Furneaux Jordan's.
2. Anterior racket incision.
3. Antero-posterior flaps.
4. Lateral flaps.
5. Flaps by transfixion.

Furneaux Jordan's external racket method is the one most commonly practised.

Position.—The pelvis rests on the extreme lower edge of the table with both limbs projecting beyond it. The sound limb is held out of the way by the assistant. The patient is turned over on the sound side with the postero-external aspect of the hip for operation fully exposed to view. Body is then brought to a Trendelenburg position. The operator stands at the outer aspect of the limb, facing the patient. One assistant manipulates the leg, another attends to the tourniquet and a third stands facing the operator.

Operation.—The operation can be described in the following stages :—

1. The limb is adducted, slightly flexed and rotated inwards. An incision is commenced two inches above the great trochanter, carried vertically downwards along the outer side of the thigh for about six inches. It divides skin and superficial fascia. At its lower end, the incision is carried inwards and outwards in order to form a large inverted Y (λ).

2. The two limbs of the inverted Y are then joined by an oblique incision made after everting the thigh. This is also subcutaneous tissue-deep. The thigh may be rotated outwards and inwards if necessary.

3. The thigh is now adducted, rotated in and flexed. The vertical incision is deepened down to the bone for its whole extent. The muscles attached to the great trochanter are then divided close to the bone. The trochanter is cleared, and in doing so, the gluteus medius and the obturator externus are cut. Extreme adduction and internal rotation of the limb will be helpful, and the excision knife will also be useful for this stage of the operation. The upper part of the shaft of the femur is cleared for the full extent of the vertical incision. Other soft tissues are also divided, *viz.*, insertions of the gluteus maximus, quadratus femoris, psoas, iliacus, pectineus, adductor longus and superior portion of quadriceps extensor. The assistant reflects the soft tissues and thus exposes the bone.

4. Disarticulation of the bone. The capsule is divided at the upper and posterior part while the limb is in extreme adduction, and anterior part of the capsule is divided when the limb is somewhat flexed. The limb is now brought to a position of complete outward rotation. The joint is opened and the teres ligament divided.

5. The muscles on the inner side of the limb are cut by a short and circular sweep of the knife and the large vessel secured with forceps.

By anterior racket incision, its handle (*i.e.*, the vertical limb) is made on a line with the femoral vessels ; these latter are exposed and ligatured, the remaining portion of the racket is made and the operation completed as in the previous operation.

Amputation by transfixion. A long transfixion knife is introduced between the trochanter and iliac crest and plunged through all the soft tissues of the thigh emerging on the inner aspect just below the level of the scrotum. The knife passes on a plane between soft tissues and anterior surface of the femur behind the femoral vessels ; it is then worked downwards with a sawing movement for about three inches and divides all the tissues from within outwards. Just before cutting the femoral vessels, the first assistant passes his fingers between the soft tissues and the bone, and controls the femoral vessels. The vessels are then secured, the flap raised, the joint opened and the head of the femur levered out. The blade of the knife is then passed behind the head of the bone and carried backwards through the soft tissues and skin, thus forming the posterior flap.

Comment.—1. The following vessels have to be secured. The external and the internal circumflex, the sciatic artery, branches of the gluteal, the superficial and deep femoral arteries, femoral and profunda veins.

Control of hæmorrhage is an important step of this operation. Of the various methods adopted for it, the following are the more effective :—(*i*) A figure of eight elastic tourniquet to compress the vessels. (*ii*) Passing skewers (Wyeth needles) in different directions through the soft tissues and applying an elastic tourniquet. (*iii*) A preliminary ligature of the femoral vessels. (*iv*) Compression of the common iliac per rectum by Davy's rectal lever. (*v*) Compression of the external or common iliac artery through abdominal incision. (*vi*) Compression of the abdominal aorta by abdominal tourniquet.

2. Sometimes the operation can be done in two stages : a modified circular amputation consisting of an external vertical incision joined to a circular incision round the limb. The thigh is amputated at its upper third. The vertical incision is extended upwards and the disarticulation then completed.

3. Of the various methods of disarticulation, the external racket method has the following advantages :—(*i*) Hæmorrhage can be controlled by the elastic tourniquet. (*ii*) The vessels and the muscles are divided transversely. (*iii*) The gluteal and sciatic vessels are divided low and as such hæmorrhage from these is comparatively less. (*iv*) The approach to the femur is through the least vascular tissues. (*v*) The hip can be exploied before disarticulation and therefore if after inspection an amputation is not considered necessary, excision can be performed. (*vi*) It gives a good stump. (*vii*) The ischium being well covered, the cicatrix brought to the outer side and a good drainage provided for. (*viii*) The transfixion method has the great advantage that it can be rapidly performed and was the operation of choice before the introduction of chloroform.

CHAPTER IX.

EXCISION OF BONES.

Indications.—Partial or complete excision of bones have to be performed for the following conditions :—

1. Osteomyelitis, caries and necrosis.
2. Extensive syphilitic or tuberculous diseases.
3. Actinomycosis and mycetoma of the bone.
4. Simple or compound fractures of a severe nature.
5. Some cases of deformity.
6. Neoplasms of bone.

EXCISION OF THE UPPER JAW.

The superior maxillary bone of one side only, or the whole of the upper jaw may be removed.

Indications.—(1) Tumours such as epulis, fibromata, sarcomata, carcinomata, odontomata (epithelial or follicular), dental cysts, chondromata and osteomata. (2) Extensive destruction of bone due to necrosis and caries from antral disease, syphilitic disease, cancrum oris, etc.

Position.—Dorsal or lateral position with the shoulder raised on sand bags or blocks, the side to be operated on being uppermost. The operator stands on the right side. One assistant stands opposite to him and another steadies the head.

Instruments.—Group VI.

The line of incision. From the middle of the upper lip upwards below the nostril, curving round the ala of the nose vertically up, along the side of the nose to the inner canthus, then outwards in the line of the lower margin of the orbit to near the outer canthus.

C. OS

8

Operation.—The operation can be described in five stages :—

1. Skin incision.
2. Raising the cheek-flap.
3. Separation of the nasal cartilages and division of the nasal bone, the orbital plate and the malar bone.
4. Division of the palate.
5. Extraction of the maxilla.

1. *The skin incision.* The assistant compresses the lip on either side of the median line. Split the lip with the knife along its median line and carry the incision down to the bone upwards along the line of incision above described, to the inner canthus. Then carry it a little superficially along the lower margin of the orbit for the rest of the line of incision.

2. *Raising the cheek-flap.* The flap thus marked out is raised from the bone and should contain all the soft structures down to the maxilla.

3. *Division of the bones, etc.* Separate the nasal cartilages from the maxilla and with the help of a fine saw and a chisel, the nasal process of the bone. Cut through the periosteum along the lower margin of the orbit and raise it with the origin of the inferior oblique muscle from the floor of the orbit. Divide as much of the orbital plate as necessary, with a pair of sharp bone-cutting forceps, commencing at the nasal process of the maxilla and ending at the spheno-maxillary fissure. Divide the malar bone obliquely from above downwards and upwards about the middle of the bone so that it extends into the spheno-maxillary fissure (Fig. 47).

4. *Division of the palate.* Open the mouth wide by a gag applied on the opposite side. Extract the upper central incisor tooth on the side of the jaw to be removed. Cut through the muco-periosteal covering of the hard palate in the median line. Make an incision by introducing the knife through the nostril on the floor of the nose close to the septum.

PLATE XIV.
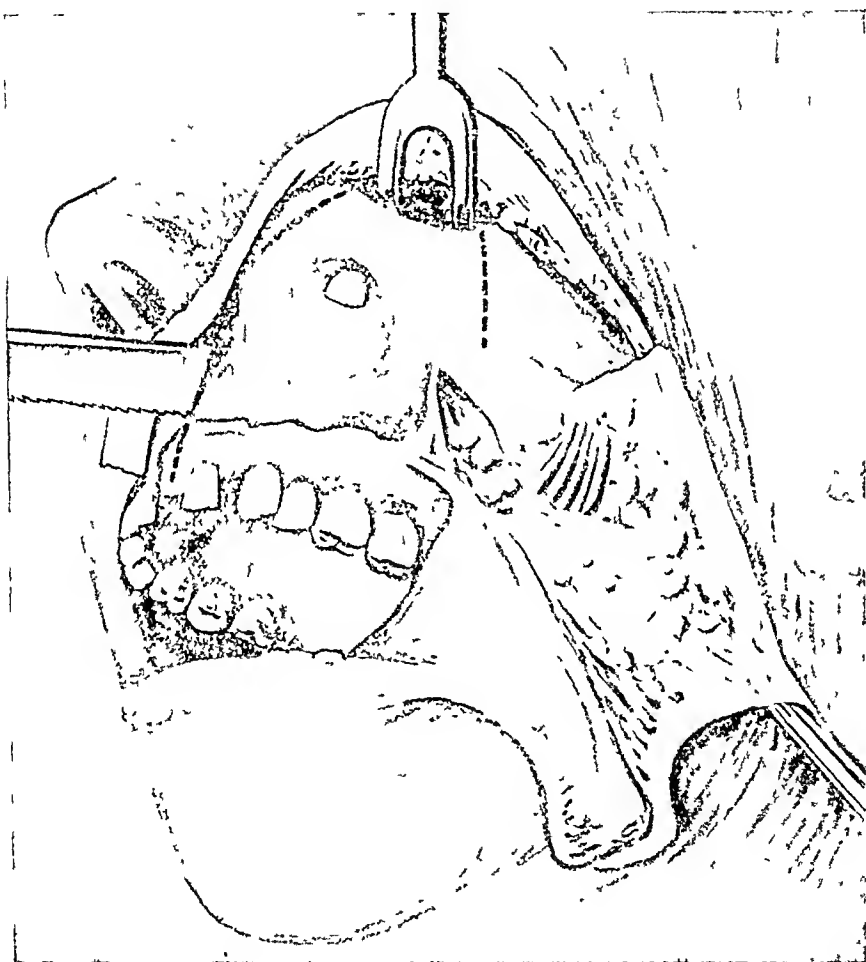
FIG. 47,
Excision of the upper jaw.

Make a transverse incision through the mouth at the junction of the soft and hard palates, separating them. Saw through the hard palate as much in the median line as possible, by introducing a narrow bladed saw of the key-hole pattern through the nostril in the same line as the muco-periosteal incision.

5. *Extraction of the maxilla.* Take a pair of lion forceps with broad blades. Grasp the maxilla by applying one of the blades to the orbital plate and the other to the alveolus. Wrench the bone out by separating a few other attachments, the chief among them being the one with the pterygoid process.

Comment.—(1) Hæmorrhage from the flap can to a great extent be controlled by pressure on the facial artery ; from the superior coronary arteries it is controlled by the assistant holding the lip on either side of the median line between the finger and the thumb. On the side of the nose and near the inner canthus the following vessels are cut : the angular artery and vein, the lateralis nasi artery, artery to the nasal septum, and the branches of the infra-orbital artery. While raising the cheek-flap the infra-orbital artery is divided and while sawing through the palate, the palatine arteries. (2) In raising the cheek-flap do not waste time in trying to save the periosteum. (3) Begin an incision below at the lip and proceed upwards. If the incision is begun above, the oozing obscures the field of operation below. Extract the incisor tooth and divide the palate last, to avoid unnecessary hæmorrhage into the mouth. (4) Some surgeons recommend a preliminary tracheotomy but this is hardly necessary. (5) In stitching up the flap, appose accurately, keeping the muco-cutaneous line on a level in order to avoid disfigurement.

EXCISION OF THE LOWER JAW (Mandible).

Indications.—(1) Extensive caries, necrosis, osteomyelitis, syphilitic and tuberculous diseases. (2) Phosphorus

necrosis. (3) Actinomycosis and mycetoma. (4) Neoplasms.
(5) Ankylosis of the jaw.

The mandible may have to be excised either for its whole
extent (complete excision) or a portion of it (partial excision),
e.g., removal of a wedge-shaped portion from the ramus or
of the condyles.

Instruments.—Group VI.

Excision of one-half of the Lower Jaw.

Position.—The patient lies upon the back close to
the edge of the table. The operator stands facing the
patient on the side to be operated on. The shoulders are
raised, the head is turned to the opposite side, one assistant
stands facing the operator and another by his side.

Operation.—This can be described in the following four
stages :—

1. Expose the facial artery, secure it between two liga-
tures and divide it (*vide supra*). Commence an incision
just below the lower lip and carry it vertically downwards
through all the soft tissues down to the bone. From the
lower end of this carry another incision along or just below
the inferior border of the jaw horizontally, and then vertically
upwards along the posterior margin of the ascending ramus
up to a point opposite the lobule of the ear. Separate the
muscles attached to the external surface of the mandible by
periosteal elevators or rougines and reflect these with the skin
upwards. The mental and masseteric vessels should be
ligatured as they are divided at this stage. Divide the mucous
membrane of the mouth, where it meets the alveolus and thus
open the buccal cavity.

2. Remove one of the incisor teeth, preferably the lateral
incisor and divide the jaw a little away from the symphisis,
by means of a narrow bladed saw or Gigli's saw completing
the section if necessary with suitable bone-cutting forceps.
Separate the attachments of genio-hyoid, genio-hyoglossus
and digastric muscles from the inner surface of the jaw.

3. Pull the cut end of the mandible outwards and separate the attachment of the mylo-hyoid muscle with a blunt pointed knife cutting close to the bone. Now raise the lower border of the mandible outwards and separate the internal pterygoid muscle from the bone. Secure the inferior dental vessels and nerve and divide them.

4. Forcibly depress the anterior portion of the jaw, exposing the coronoid process and divide the tendon of the temporal muscle, with a suitable pair of scissors. Depress the jaw further bringing the condyle into view. Detach the external pterygoid muscle from it and divide it. Cut through the capsule and free the condyle. Cut through internal lateral stylo-maxillary and the pterygo-maxillary ligaments if they have not already been separated. Secure all bleeding points and unite the wound by silkworm gut sutures. Drain the posterior part of the wound and pack the anterior part (Fig. 48).

Comment.—(1) Throughout the operation the knife or the periosteal elevator should be kept close to the bone. (2) During the third stage of the operation avoid injury to the sub-maxillary and sub-lingual glands. (3) Do not twist or rotate the jaw but only depress it during the latter part of the operation, otherwise the internal maxillary artery may be injured by the neck of the jaw.

RESECTION OF RIBS.

Indications.—

1. Caries and necrosis of ribs.

2. Some cases of empyema.

3. Fracture of a rib (simple or compound) with signs of injury of internal organs, *e.g.*, the lung or pleura.

4. Wounds of intercostal vessels.

5. New growths either secondary or primary or extension from the adjacent tissues or organs.

6. Some cases of abscesses in the liver.
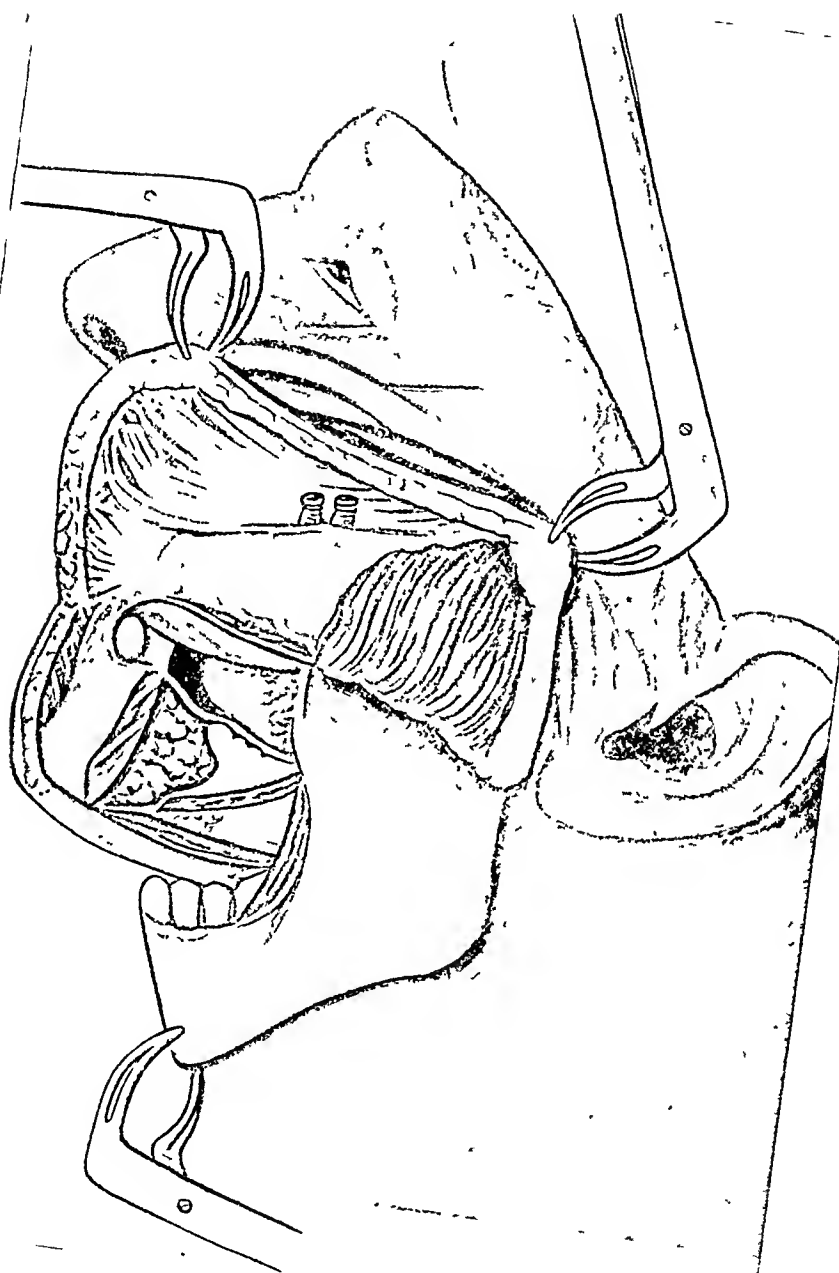
FIG 48
Excision of the lower jaw.

Position.—Place the patient at the edge of the table, supported on a sandbag, so that he is lying partly on the sound side. The hand is held away from the side by an assistant.

Instruments.—Group VII.

Operation.—Select the rib. Steady the skin with the fingers and thumb of the left hand. With a strong scalpel or excision knife make a longitudinal incision about three inches long, along the middle line of the rib down to the bone. Another touch of the knife may be necessary to cut through the periosteum in the line of the incision. Elevate the periosteum by a periosteal elevator from the outer surface of the rib towards the two flaps, above and below ; with a curved periosteal elevator raise the periosteum from the upper or lower margins of the rib keeping rigidly close to the bone so as not to injure the intercostal vessels in the groove along the lower border of the rib. Then insinuate a curved elevator between the periosteum and the inner aspect of the rib, separating it from the bone, taking great care not to injure the pleura or lung. The rib is now free of all soft tissues. Pass a gauze retractor behind the rib, protecting the soft tissues. Now the rib can be cut in one of the following ways : (*i*) make two vertical impressions on the rib by means of small metacarpal or Hey's saw on the lines up to which the periosteum has been raised. Remove a portion of the rib between these two impressions by cutting with the rib-shear ; (*ii*) pass the wire of the Gigli's saw round the rib and cut through the bone on the intended lines ; (*iii*) some use rib-shear directly, without making a previous impression with the saw. This may, however, crush or splinter the rib (Fig. 49).

Comment.—(1) Make the incision along the middle line of the rib, *i.e.*, midway between the upper and the lower borders. (2) While reflecting the periosteum, avoid injuring the intercostal vessels and nerves, the pleura and the lung. (3) Do not leave any portion of the rib denuded of periosteum, it may undergo necrosis. (4) Use a Hey's saw or a metacarpal

PLATE XVI.
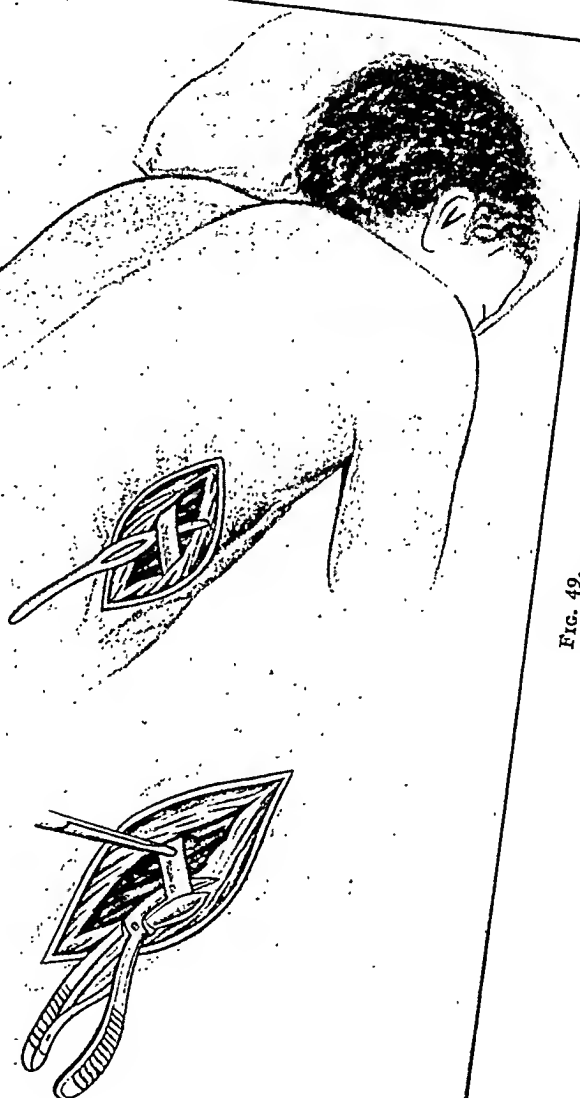
Fig. 49.
esection of ribs.

saw. Gigli's saw will also be handy but must not be used without a protector. (5) Ordinarily, it may be necessary to resect one-half to two inches of the rib, but under exceptional circumstances more of one rib or even two or three ribs may have to be excised. (6) For empyema an effective drainage can be obtained by the resection of the ninth rib between the scapular ' and posterior axillary lines ; for liver abscess (*vide infra*). (7) For accidental injury to the intercostal vessels they can be compressed between the finger and the inner surface of the rib, a ligature passed round the rib including the vessels. Resection of the rib can thus be avoided.

EXCISION OF THE ASTRAGALUS.

Indications.—

1. Tubercular disease confined to the bone.
2. Some cases of talipes and flat-foot.
3. Old unreduced dislocations.

Operation.—(*a*) Incision. Two lateral incisions are made : (*i*) external incision two inches long from above and front of the external malleolus downwards to the middle of the dorsum of the cuboid bone ; (*ii*) internal incision two inches long from below the tip of the internal malleolus curving upwards and forwards to a point in front of the tibia just above the internal malleolus. (*b*) Raise two small flaps, deepen the incision to the bone ; invert and extend the foot strongly to stretch the external ligaments. (*c*) Divide the ligaments which bind the astragalus to the tibia and fibula, scaphoid and os calcis. Turn to the inner side and divide the ligaments on this aspect including the astragalo-calcanean ligaments. Now expose the upper articular extremity of the astragalus and protrude it through the outer incision by inverting and extending the foot. (*d*) Deliver the astragalus through this wound by grasping it with lion forceps and pulling it in a vertical direction.

Comment.—No muscles have to be cut as there is no muscular attachment to the astragalus.

CHAPTER X.

OPERATIONS ON BONES.

Osteotomy.

By osteotomy is meant a simple division of bone. In linear osteotomy the bone is divided in its continuity; generally the division is made along a single transverse line. In cuneiform osteotomy a wedge-shaped piece is removed from the bone.

Indications.—

1. For correction of deformities such as due to (*a*) rickets, *e.g.*, genu valgum and genu varum; (*b*) congenital causes, *e.g.*, coxa vara, and (*c*) other causes, *e.g.*, talipes varus.

2. For correction of a deformity due to faulty ankylosis.

3. For rectifying malunion after a fracture.

Instruments.—Group V.

Operation.—Osteotomy can be performed in two ways.

Subcutaneous method.—Make a clean cut down to the bone with a stout knife, such as an excision knife parallel to the long axis of the shaft. Clear the bone of all soft tissues by a raspatory, pass the saw or osteotome flat-wise along this opening. Now turn these instruments so that the cutting edge is at right angles to the shaft, and divide the bone. The bone can be divided entirely for its whole thickness or the major portion of the bone is divided and then fractured.

Open method.—Make an incision sufficiently long to expose the bone and then divide it as in the previous operation. It may sometimes require some form of fixation apparatus to keep the ends of the divided bone in position.

Comment.—What has been called the subcutaneous osteotomy is hardly a subcutaneous operation. While performing this operation due regard should be made of the important structures, such as vessels or nerves in the immediate vicinity of the bone. It is much safer to make a wound large enough to expose the bones and other structures ; besides, in these days of aseptic surgery smallness of the wound is not an essential point.

The bone can be divided by linear or cuneiform osteotomy ; either in the subcutaneous or open method.

Linear osteotomy.

Place the limb in a suitable position steadying it by means of sandbags. Make an incision as has been described but so place it that it avoids important structures and allows the easiest and nearest access to the bone. Do not withdraw the knife but use it as a guide for the osteotome or the saw. Hold the osteotome by the left hand and drive it through the bone by steady strokes of the mallet. Hold the chisel in such a way that the cutting edge is directed towards you and the division of the bone is commenced from a part farthest from you. An approximate idea of the thickness of the bone should be made and the extent of bone-cut should be gauged by the graduations on the osteotome.

Cuneiform osteotomy.

Determine the exact shape, size and position of the wedge required to correct the deformity. The incision in the soft tissues must be comparatively larger. Expose the bone and raise the periosteum with the elevator. In dividing the bone use an osteotome, a chisel or a saw and while using the former two instruments, hold them in such a way that the bevelled edge is towards the portion to be removed. Small wedges can be removed in one piece but larger wedges can be removed in sections. Let the periosteal flaps come together and close the wound.

SUPRA-CONDYLOID OSTEOTOMY (Macewen).

Indications.—Genu valgum of a severe type in which the separation between the maleoli is more than three inches and a half.

Position.—Abduct and rotate the thigh outwards, flex the knee to an angle of about 140° and let it rest on its outer side on a firm sandbag, so that the inner aspect of the limb is exposed to the operator. The operator stands on the outer side of the limb and the assistant stands facing him.

Operation.—Draw a line horizontally across thigh, a finger's breadth above the upper limit of the external condyle and another line vertically a finger's breadth in front of adductor tubercle to meet the former line. Plunge the knife at this junction down to the bone and introduce the osteotome flat-wise guided by the blade of the knife. Now withdraw the knife and hold the osteotome firmly against the bone and divide the bone by light strokes of the hammer or mallet three quarters of its thickness, and then fracture it by bending the limb sharply inwards. Then bring the limb to the fully corrected position. Close the wound and fix the limb by splints in corrected position.

SEQUESTROTOMY.

Indications.—

1. For the removal of a sequestrum resulting from acute infective osteomyelitis.

2. For the removal of sequestrum caused by traumatic septic necrosis, *e.g.*, after a compound fracture.

3. For removing sequestra caused by specific infection such as (*a*) syphilitic, (*b*) tuberculous, etc.

4. In quiet necrosis.

Instruments.—Group V.

Operation.—I. Removal of sequestrum in cases of acute infective osteomyelitis.

Consider the following points :—(1) The period at which to operate. Early intervention is indicated because (*a*) the

wound heals earlier and the patient will not need prolonged stay in bed and a long course of dressing; (*b*) the longer one waits the less will be prospects of regeneration of the new bone to take the place of the sequestrum.. (2) The periosteum should be preserved as much as possible as this is the only source of new bone formation. (3) The period and the extent of demarkation between the living and the dead bone should be determined by a skiagram. Make an incision down to the bone in order to expose the whole of the affected part. Reflect the divided periosteum with rougine or periosteum elevator. Avoid injuring the periosteum, this exposes the necrosed bone; remove its whole extent even if it be the whole shaft of the bone. Bring the reflected periosteum together if necessary with sutures. Bring together the soft tissues and stitch up the skin leaving enough room for drainage. Immobilise the limb by means of splints or plaster of Paris bandage.

II. Removal of sequestrum in chronic cases. Make one or more longitudinal incisions including in them the opening of any sinuses in the skin. Reflect the periosteum exposing one or more of the cloacæ and cut through the involucrum with chisels, gouges and bone nippers between the cloacæ working upwards and downwards; the sequestrum will be found more or less loose in the antrum. If it is a small sequestrum it can be removed in one piece, but if it is a large piece of sequestrum and it cannot be removed entire without doing much damage to the involucrum, divide and remove it piecemeal, scrape away unhealthy granulation tissue from the walls of the antrum, purify it and pack it. Now attend to the skin, snip away with scissor any unhealthy margins of the skin as will be found at the opening of the sinus and bring the edges of the skin together by interrupted sutures leaving opening for efficient drainage.

CHAPTER XI.

OPERATIONS ON FRACTURES.

Two different views are held regarding the treatment of fractures of bones. According to one school, all fractures simple and compound should be treated by open operation but in view of the severity of the operation and tropical conditions we limit operative interference for such conditions as are indicated below :—

Indications.—

1. Certain fractures which cannot be treated otherwise than by an open operation such as fractures of the patella and olecranon in which due to muscular action, there is generally a considerable amount of destruction.

2. Some cases of oblique fractures of the bone of the leg and forearm where first of all apposition is difficult to bring about and secondly cross-union and malunion are very common.

3. Cases in which deformity cannot be reduced by any other means.

4. Fractures in the neighbourhood of joints.

5. Fractures complicated with dislocations.

6. Fractures in which there is interposition of soft tissues between the fractured ends.

7. Cases of multiple fractures.

8. In some cases of comminuted fractures.

9. Compound fractures in which there is free communication between the fracture and the external wound.

10. In cases of long-standing fractures with malunion, delayed union or non-union.

Operation.—The proximal and distal ends of fracture can be brought together by various methods : (*a*) absorbable sutures, *e.g.*, catgut ; (*b*) unabsorbable sutures, *e.g.*, silk, silkworm gut, wire ; (*c*) nail, screws and pegs of metal or ivory ; (*d*) metal plates and collars, *e.g.*, Lane's plates.

SUTURING THE PATELLA.

Fragments of fractured patella can be apposed by various methods.

1. Barker's fixation by subcutaneous method.— The suture is passed through the skin behind the patella (through the knee-joint) and brought through the skin again and then tied.

2. Silk suture (Stimson's method).—The patella is exposed by incision and sutures are passed transversely through the ligamentum patellæ below-carried upwards and passed transversely again through the quadriceps extensor and the ends tied.

3. Suture of the capsule (Valas's method).—The patella is exposed and several blanket sutures are passed through the capsule and tied off tight.

4. Suturing of the patella by open method.— All fractures of the patella with the exception of stellate and vertical fractures should be sutured for the following reasons :—

1. In transverse fracture there is much distraction of the fragments and their coaptation is impossible.

2. Unless the fragments are united by suture, fibrous union is the rule.

3. The lower fragment is generally tilted in such a way that apposition of the fractured surfaces is difficult or impossible without suturing.

4. The capsule or periosteum is generally torn at a lower level than the line of fracture and as such its free margin hangs as a fringe from the upper fragment, interposing between the fractured surfaces.

5. Fracture of the patella is generally associated with rupture of the lateral expansions of the quadriceps extensor tendon.

6. It being an intra-articular fracture there is much effusion and collection of blood clot in the joint and between the fragments.

7. Suturing the patella facilitates early union and passive movement can be commenced earlier and ankylosis is rare.

Instruments.—Group IV.

Position.—The patient lies on his back with the affected limb near the edge of the table, the operator stands facing it and the chief assistant stands opposite to him ; another assistant stands at the foot of the table supporting the leg, in order to flex and extend the limb as required.

Operation.—Different operations have been recommended but Lord Lister's classical method will be described here.

Incision. A horse-shoe shaped or semilunar incision is commenced at a point a little lower than the line of fracture, carried upwards so that its convexity (upper limit) lies a little above the patella and then downwards to a point corresponding to the commencement of the incision. It is so placed that the vertical parts of the incisions are about three-fourths of an inch away from the outer and inner margins of the patella.

The flap. Turn down the skin-flap by light touches of the knife. This opens the prepatellar bursa, exposes the fracture and the torn capsule (Fig. 50).

Wash out all blood clot and cut away any soft tissue interposed between the fragments. Freshen the fractured surfaces by scraping away any fibrous tissue, clots, etc., that may have formed especially in old-standing fractures.

Suturing the patella. Make a small puncture through the soft tissues down to the bone on the upper fragment about half an inch above the broken margin. Introduce a bone drill through this incision in such a direction that it emerges

from the fractured surface just in front of the articular cartilage.　Pass the suturing material, silver wire, silkworm gut, silk or catgut along the groove of the drill ; this can also be conducted by means of a hole in· the drill or by a needle passed along the track left on withdrawing the drill.　The lower fragment is drilled in a similar manner taking care that the hole is on a corresponding point and as near the apex as possible.　The free end of the suture emerging from the fractured surface of the upper fragment is now introduced through the same surface of the lower fragment and taken out through its anterior surface.　If there are indications for further strengthening the union, a second suture may be applied in a similar way.　The limb is now over-extended and the fragments brought together by manipulating from above and below.　It is then tied by twisting or knotting and then buried into the anterior surface of the bone.　If there are more than two fragments, the lower fragment being split into two, these can be brought together by separate sutures (Fig. 51).

The capsular ligament and the lateral expansion.　It is important to bring together the ruptured capsular ligament and the lateral expansion of the quadriceps extensor by a few catgut or silk sutures.　Close the wound without drainage (Fig. 52).
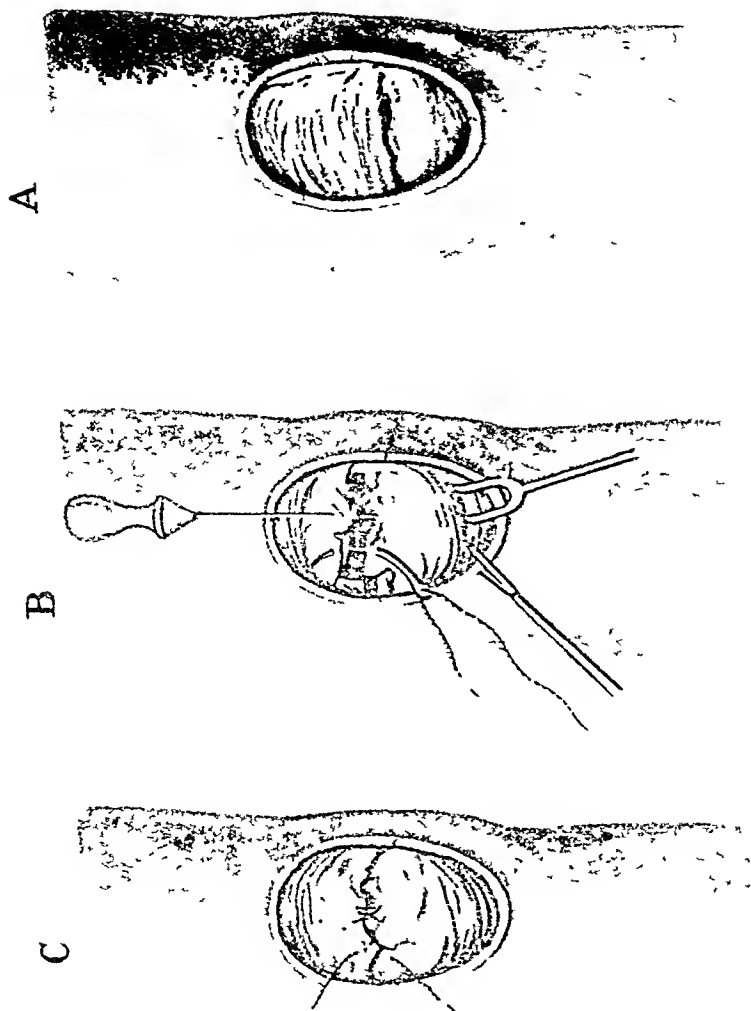
FIG. 50

FIG. 51.

FIG. 52.

Suturing of the patella. The horse-shoe shaped flap is not shown for clearness.

CHAPTER XII.

OPERATIONS ON JOINTS.

ARTHROTOMY.

Indications.—(1) For suppurative arthritis. (2) For septic compound fractures involving the joint.

Operation.—One or more incisions should be made to ensure free drainage. Scrape away unhealthy granulations. Fix the limb in sterilizable interrupted splint to facilitate dressing in a position which allows the greatest space to the joint. The space can be packed, treated by continuous irrigation by Carrel-Dakin method or the author's modification by continuous capillary drainage (Figs. 53 and 54).

EXCISION OF JOINTS.

By excision of a joint is meant the removal of articular extremities of bones entering into the formation of the joint, together with the joint structures and peri-articular tissues. This is subject to two exceptions in which only one of two articular extremities is removed, e.g., the hip-joint and the shoulder-joint.

Indications.—Excisions are performed for :—

(a) Diseased conditions of articular ends and articular and peri-articular structures.

(b) Ankylosis due to (i) traumatic lesions such as dislocations, fracture-dislocations and (ii) chronic pathological conditions giving rise to adhesions.

(c) Providing an artificial movable joint as for ankylosed elbow-joint.

(d) Providing a fixed joint in good position by bony ankylosis.

PLATE XVIII.

A

B

Author's modification of capillary wire drain.
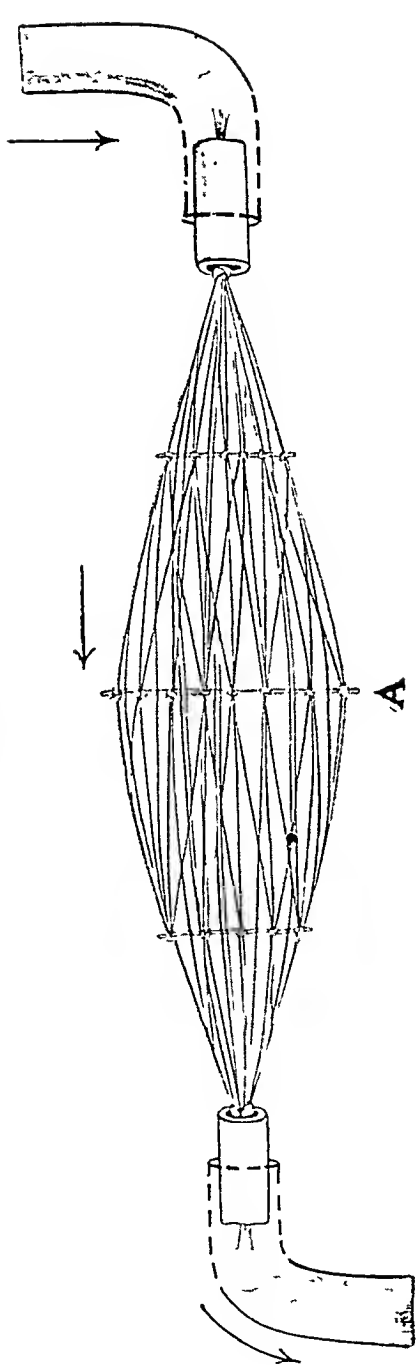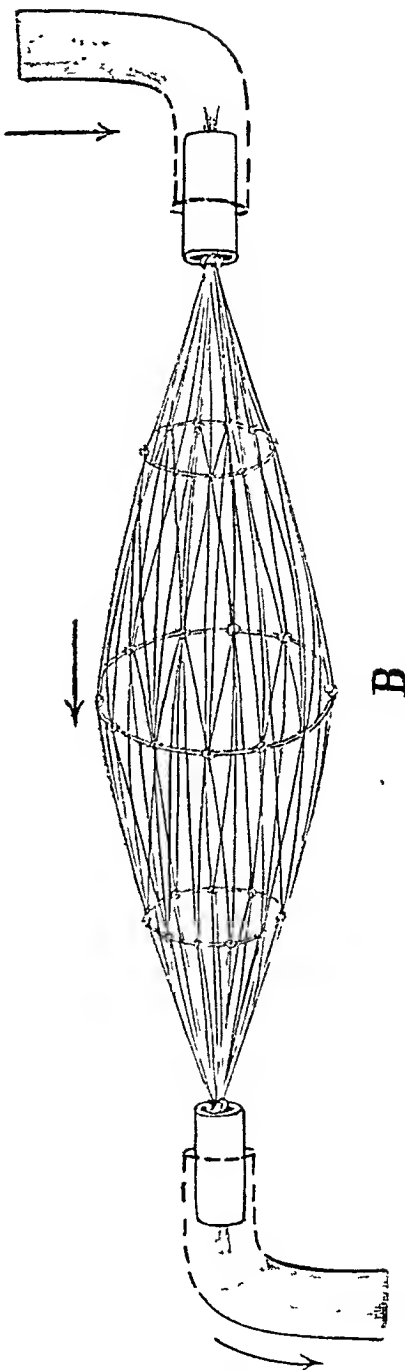
FIG. 53.   FIG. 54.

There are two methods of excision :—

1. The subperiosteal method. - In this an attempt is made, if possible, to save the whole of periosteum covering the portions of bone to be excised. The attachment of the ligaments and the capsule are preserved, the joint being in a way shelled out from the surrounding periosteum. This is an ideal method of excision in theory, but it is attended with much difficulty. The peeling off of the periosteum is difficult, and more so, when operating upon the dead subject. Besides, it takes up much longer time and it is difficult to decide whether the periosteum is healthy or not.

2. The open method.—This consists in removing extremities of bone and diseased tissues regardless of the periosteum. The ligaments of the joint are equally divided, the soft tissues are not damaged and the tendons attached to the bones are generally spared by separation of the periosteum.

Comment.—Certain rules are to be observed in this operation, *viz.*, (*i*) the soft parts should be injured as little as possible ; (*ii*) epiphysis should be preserved whenever possible ; (*iii*) it must be seen that all the diseased tissues are removed, and (*iv*) that the joint is more useful to the patient after excision, than it was before.

THE UPPER EXTREMITY.

EXCISION OF THE WRIST-JOINT.

Complete excision of the wrist-joint means removal of the entire carpus, the lower extremities of radius and ulna and the proximal ends of the metacarpal bones. The large number of tendons and the firm ligamentous attachments make the operation rather difficult. Various operations are known but Kocher's method by dorso-ulnar incision is the best.

Kocher's excision of the wrist by dorso-ulnar incision.

Operation.—Flex the hand slightly. Commence an incision skin-and-fascia deep, three and half inches long

opposite the middle of the fifth metacarpal bone on the ulnar aspect and carry it with a convexity towards the thumb in an upward and outward direction to the middle of the dorsum of the wrist, and then a short distance up the middle line of the forearm. Avoid the dorsal branch of the ulnar nerve at the lower end of the incision. Deepen the incision by cutting through the posterior annular ligament, thus exposing the tendon sheaths. The sheaths including the extensor communis digitorum and extensor minimi tendons are retracted outwards. The ligaments connecting the base of the fifth metacarpal, unciform and cuneiform bones and the lower end of ulna are divided. Open the capsule of the wrist-joint on the ulnar aspect, and divide the tendon of the extensor carpi ulnaris. Remove the flexor carpi ulnaris tendon from the groove in the ulna above and detach the capsule further from the lower end of that bone. Separate the pisiform bone from the cunei- form, the tendon of the flexor carpi ulnaris retaining its con- nection with the pisiform. Cut across the hook of the unci- form bone saving the deep branch of the ulnar artery which passes round it. Lift out the flexor tendons on the palmar surface *en masse* ; cut through the ligamentous attachments between the inner three metacarpal bones, preserving the tendon attached to the second and third metacarpal bones. Divide the anterior and posterior ligaments. Dislocate the whole hand towards the flexor and radial side. Remove the carpal bones, saw through the lower ends of radius and ulna and the proximal ends of the metacarpal bones.

EXCISION OF THE ELBOW-JOINT.

Surgical Anatomy.—With the arm extended. (1, The humeral epicondyles are on a line with the tip of the olecranon. (2) Just below the external condyle in the dimple can be felt the head of the radius if the forearm is pronated and supinated. (3) Just to the outer side of the internal condyle, and between it and the olecranon is a deep groove in which the ulnar nerve can be rolled under the finger.

The epiphyseal junction of the humerus corresponds to a transverse line drawn across the humerus just above the tips of the condyles. The humero-radial articulation is transverse and is three-fourths of an inch below the external condyle. The humero-ulnar articulation is more than an inch below the internal condyle.

Various incisions are made use of in order to obtain free access to the elbow-joint, *viz.*, (*i*) posterior median incision (Parke), (*ii*) long radial incision (Huet), (*iii*) longitudinal and transverse incisions (Nelaton) and (*iv*) H-shaped incision (Syme). Of these the first is recommended.

Excision of the Elbow-joint by posterior median incision.

Position.—Put the patient near the edge of the table and stand on the side to be operated upon. Flex the elbow and draw the forearm across the chest, making the elbow prominent. The assistant stands on the opposite of the table and supports the arm and forearm with his two hands. A second assistant will be useful to retract the soft parts.

Instruments.—Group IV.

Operation.—The operation is described in four stages :—

(*a*) *Incision.* An incision is made along the posterior aspect of the elbow-joint four inches long and so placed that the middle of the incision lies over the tip of the olecranon. It is carried deep down to the bone, the upper half dividing the tendon of the triceps vertically and the lower half the soft tissues covering the olecranon process and ulna. (For this an excision knife is useful.) This opens the articulation through posterior ligaments.

(*b*) *Clearing of the soft tissues from the bone, i.e.,* from the condyle of the humerus and olecranon. For this stage of the operation the excision knife should be used and periosteal elevators and a blunt dissector will also be useful.

First, turn to the inner part of the incision. Begin by peeling off the triceps with the periosteum from the olecranon.

PLATE XIX.
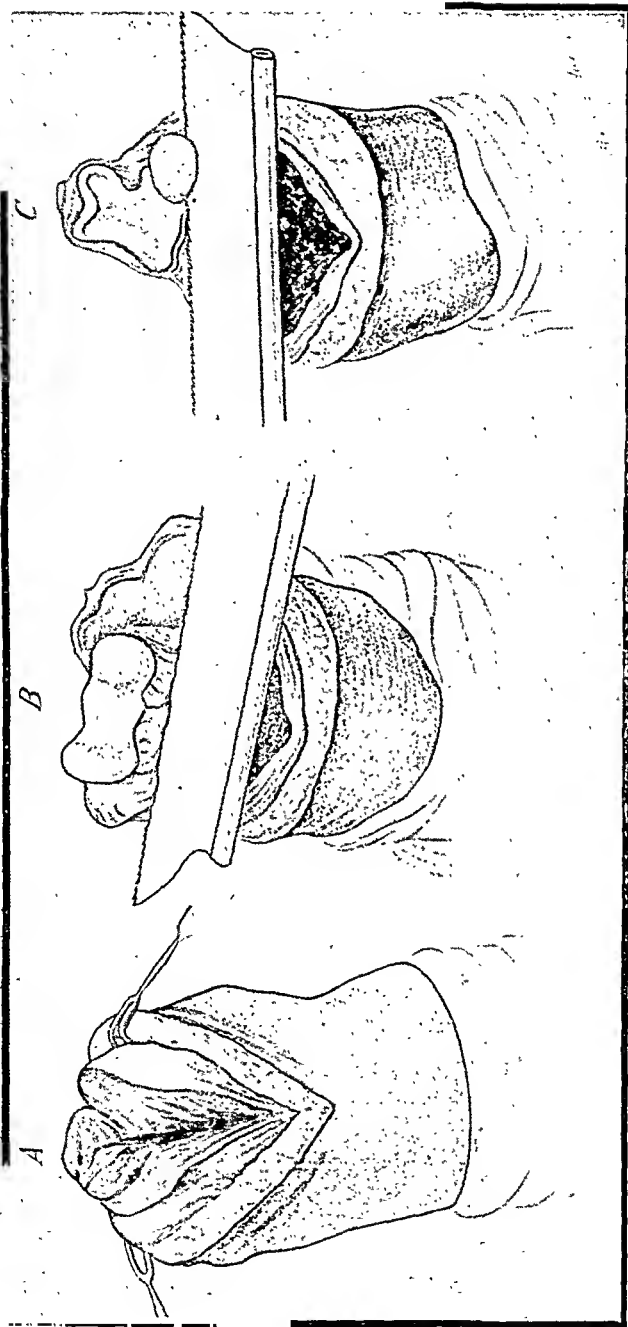
FIG. 55.

FIG. 56.

FIG. 57.

Excision of the elbow-joint.

Raise the soft tissues from the depression, between the olecranon and the internal condyle thus exposing the bone. The soft tissues include the muscles, the ulnar nerve, the internal lateral ligaments and the periosteum, carrying with it the origin of flexor muscles.

Next, turn to the outer part of the incision and in a similar manner separate the soft tissues on this aspect until the outer epicondyle is laid bare. These tissues include the outer half of the triceps tendon, the anconeus, the external lateral ligament, the origin of the extensor muscles and the supinator brevis. The posterior interosseous nerve may come into view and should be saved. Retract the soft tissues on the inner and outer aspects of the incision. The joint is now entirely free on its posterior aspect and the bones can be protruded out of the wound.

(c) *Sawing off the end of the humerus.* Flex the elbow fully and get your assistant to protrude the lower end of the humerus forcibly through the wound. Clear the bone of any attachment in front, retract and protect the soft parts with gauze retractors (Fig. 36). Grasp the bone with lion forceps and hold it vertically ; apply the saw to the bone at right angles to its long axis just below the tip of the condyles and saw through the bone horizontally (Figs. 55 and 56).

(d) *Sawing off the ends of the radius and ulna.* Protrude the upper end of the radius and ulna through the wound, hold the olecranon process with lion forceps vertically. Apply gauze retractors as in the cases of the humerus. Place the saw horizontally in such a manner that it passes below the base of the olecranon and the coronoid processes and just above the bicipital tuberosity of the radius. Saw through the upper ends of both the bones on these lines. Displace the supinator brevis downwards before sawing and try to spare as much of the attachment of brachialis anticus to the coronoid process as possible. Smooth off any sharp edges of the cut ends of the bone with bone-cutting forceps (Fig. 57).

Comment.—(1) Remove sufficient amount of the bones to give an efficient movable joint. The level of the section of the humerus is below the level of the tips of the condyle but it can go higher. The level of the section of radius and ulna has been described. Do not interfere with the insertion of the biceps tendon to the bicipital tuberosity of the radius. (2) Take care not to wound the ulnar nerve just behind the internal condyle internally, and the posterior interosseous nerve externally. (3) Keep the knife well down upon the bone and the edge of the blade turned towards it. Make short and firm cuts. Use the periosteal elevator and the blunt resector more freely than the knife. (4) While peeling off the soft structures on the outer aspect, separate the triceps and anconeus in one piece. (5) Do not let your assistant twist the arm or forearm as this would disturb the anatomical relations and confuse you.

EXCISION OF THE SHOULDER-JOINT.

This operation consists of an excision of the upper end of the humerus. The socket of the joint, *i.e.*, the glenoid fossa of the scapula, is not generally disturbed. Occasionally, however, portions of the articular surface and the bone of this fossa have to be gouged out. The operation is rarely performed and is indicated for the following conditions :—

1. Chronic disease of the joint, tuberculous or otherwise.

2. Old standing injury or disease giving rise to ankylosis. It must be remembered that considerable movement of the arm is possible with an ankylosed shoulder through the movements of the scapula on the trunk.

3. For new growths limited to the upper end of the humerus.

Surgical Anatomy.—The following anatomical points are worth remembering :—

1. In the groove between the deltoid and the pectoralis major at the front of the joint are the cephalic veins and the acromio-thoracic artery.

2. Under the outer third of the clavicle and through the fibres of the deltoid and pectoralis major can be felt the coracoid process.

3. The bicipital groove with the tendon of the biceps lying in it can be felt when the arm is slightly rotated outwards.

4. The tip of the acromian can be easily felt overhanging the joint.

5. The greater tuberosity can be felt deeply through the deltoid; to this are attached the supra-spinatus, infra-spinatus and teres minor. The lesser tuberosity, more in front, has subscapularis attached to it.

Instruments.—Group IV.

Operation.—Several incisions can be made use of to gain a free access to the shoulder-joint, *viz.*:—

1. The anterior incision.

2. Langenbeck's vertical incision which is placed more externally than the above.

3. The anterior flap method.

Of these three, the anterior incision is the one most commonly adopted because, (*i*) it gives free access to the joint without much injury to the muscles or their nerve supply, (*ii*) this incision can be easily converted into the one for Spence's disarticulation, should it be found necessary during the course of the operation, to remove the limb in consideration of extensive involvement of the bone.

Excision of the Shoulder-joint (by anterior incision).

Position.—The patient lies close to the edge of the table. Raise the shoulder, flex the elbow and slightly abduct it. Stand facing the shoulder; the assistant stands behind you, manipulating the arm.

Operation.—The operation is completed in four stages :—

1. *The incision.* Make an incision about four inches long from the coracoid process downwards and outwards

PLATE XX.

Dissarticulation of the head of the Humerus in Excision of the Shoulder-joint. The arm is vertical and the head of the bone can be pushed well up out of the wound.
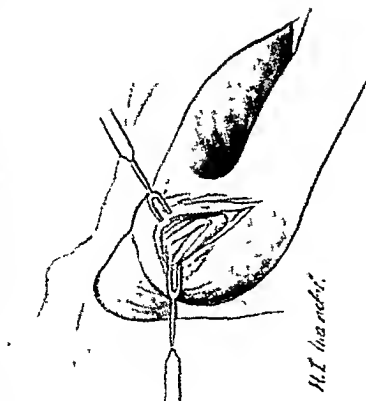
Excision of the Shoulder-joint. The Biceps has been lifted out of its groove.

H.L. Isarde.
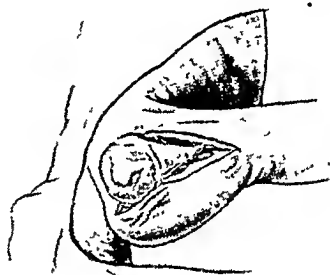
Shewing the Head of the Humerus in Excision of the Shoulder-joint. The soft parts are protected by a spatula.
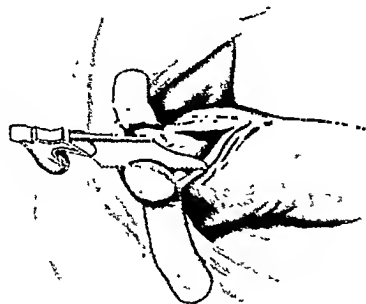
FIG. 58.

FIG. 59.

FIG. 60.

Excision of the Shoulder-joint.

through the anterior fibres of the deltoid muscle, cutting through all the soft tissues down to the shaft of the humerus. The coraco-acromial arch and the capsule are exposed. Feel for the biceps tendon in the bicipital groove, and do not injure it. Open the capsule of the joint on the outer side of the tendon (Fig. 58).

2. *Clearing of the outer aspect of the wound.* Clear all soft tissues from the bone at the outer margin of the wound and retract them outwards. The assistant rotates the arm strongly inwards and forces the head of the bone forwards. The great tuberosity is exposed with the tendons of the supra-spinatus, infra-spinatus and teres minor inserted into it. These are separated by cutting down upon the tuberosity with an excision knife. Clear this aspect of the head of the humerus of the capsule.

3. *Clearing of the inner aspect of the wound.* Rotate the humerus outwards. Separate the parts in a similar manner, retract and protect the biceps tendon. The lesser tuberosity with the insertion of the subscapularis is exposed. Divide it by cutting down upon the tuberosity. Push the head of the humerus upwards, dislocating it from the glenoid cavity, the biceps tendon being retracted inwards. Clear the posterior part of the neck of the humerus (Fig. 59).

4. *Excision of the head through the neck.* Hold the head of the bone by lion forceps with your left hand. Protect the soft tissues with gauze retractors. Apply a small butcher's saw or Gigli's wire saw to the bone and remove the head either through the anatomical neck, or below the tuberosities as is required (Fig. 60).

The glenoid cavity may be examined and gouged, if necessary.

Comment.—(1) Avoid the cephalic vein as it lies between the deltoid and pectoralis major. (2) Take special care not to injure the tendon of the biceps. (3) In sawing through the neck, incline your saw from without slightly downwards and inwards to avoid any sharp edge being left on the inner

side, as this may injure the axillary vessels and nerves.   Do
not remove more bone than is necessary.

LOWER EXTREMITY.

EXCISION OF THE ANKLE-JOINT.

The upper articular surface of the astragalus together
with the lower end of the tibia and fibula are removed.
Kocher's external curved incision is generally employed.   The
after-results of this operation are very seldom satisfactory
due to the complexity of the joint and the involvement of the
astragalo-tarsal joints in the disease.

EXCISION OF THE KNEE-JOINT (COMPLETE ARTHRECTOMY).

In this operation the articular surfaces of the femur and
tibia are removed in order to appose the sawn surfaces and
bring about bony ankylosis in the straight position.   The
indication for this operation is extensive disease of the
articular ends of the joint and other joint structures which
cannot be extirpated by milder measures.

Surgical Anatomy.– (1)   The lower epiphysis of the
femur is on a level of the adductor tubercle.   (2)   The upper
tibial epiphysis is along a transverse line across the head of
the tibia, just taking in the articular facet for the head of
the fibula externally, and the point for the insertion of the
semi-membranosus internally.   In front, it comes to a lower
level and includes the tibial tuberosity.   (3)   The popliteal
artery lies directly against the knee-joint posteriorly, separated
from it only by the posterior ligament and some fat.

Instruments.—Group IV.

Position.—Place the limb close to the margin of the
table with the lower part of the leg, projecting a little beyond
in order to facilitate flexion, extension and other movements
during the operation.   The operator stands on the outer side
and the assistant opposite to him.   A second assistant is
helpful to manipulate the limb for different positions.

Excision of the Knee-joint by a curved anterior incision.

The operation can be described in five stages—

1. *The skin incision.* Hold the knee-joint slightly flexed and make an incision skin and subcutaneous tissue deep, commencing at the posterior margin of one femoral condyle and carrying it down in a curved manner with the convexity downwards to the insertion of the patellar ligament, and carrying it up again to end at the posterior margin of the opposite condyle.

2. *Division of ligaments.* Flex the knee further. Cut through the anterior part of the capsule and the patellar ligament by one sweep of the knife. The joint is, therefore, open below the patella. Reflect the patella and soft tissues upwards. Flex the knee further and cut through the lateral · and the two crucial ligaments.

3. *Sawing of the femur.* · Flex the knee to a right angle, the sole of the foot rests on the table and the femur rests on the tibia. Clear the lower end of the femur up to the saw line, of all soft tissues, particularly those on the posterior aspect, including the popliteal vessels and nerve and protect these by gauze retractors. The lower end of the femur with the condyle is grasped with a large pair of lion forceps. Saw the femur from before backwards, so that the plane of the saw cuts at right angles to the long axis of its shaft.

4. *Sawing of the tibia.* The upper end of the tibia is now pushed forwards, the sole being firmly supported on the table. Clear the bone of any remaining soft tissues and saw a thin slice of its upper edge, working the saw from before backwards and keeping it strictly parallel to the articular surface, *i.e.*, at right angles to the shaft.

5. *The patellar and synovial membranes* should be treated now. The patella may be removed if unhealthy, otherwise not. Remove all diseased synovial sac including the · pouch under the quadriceps extensor.

Comment.—(1) Particular attention has to be paid towards proper and adequate apposition of the sawn surfaces. The bones must be divided in such a way that their sawn surfaces are in the same plane as their normal articular surfaces. (2) In making the skin incision do not go too far behind the internal condyle and thus avoid cutting the internal saphenous nerve. (3) Do not saw through or above the epiphyseal lines of either bone. (4) Take good care to protect the soft tissues in the posterior aspect of the joint. They contain vessels and nerves. The posterior ligament should be spared as much as possible, as it lends a good support to that aspect of the joint.

EXCISION OF THE HIP-JOINT.

By this operation is meant excision of the upper end of the femur, and treatment of the socket, *i.e.*, the acetabulum in a manner similar to that of the glenoid cavity in excision of the shoulder-joint.

Several methods of this operation are known but the one through an anterior incision is recommended.

Position.—Dorsal position near the edge of the table is suitable. The operator stands on the affected side and the assistant faces him. A second assistant takes charge of the limb and does the necessary manipulation.

Operation.—Make an incision through the skin and fascia on the outer aspect of the thigh, commencing about half an inch below the anterior superior iliac spine and carrying it downwards and inwards for about three and a half inches. Separate the muscles by blunt dissection. Retract sartorius and rectus femoris inwards, and tensor fasciæ femoris and gluteus medius and minimus outwards. Through an interval between the muscles the capsule is reached and cut. With the head of the bone still in the socket, the neck of the femur is divided by a narrow saw, such as Adam's. Deliver the head out of the socket by means of a curved periosteal elevator.

CHAPTER XIII.

OPERATIONS IN THE MIDDLE LINE OF THE NECK.

Surgical Anatomy.—Certain anatomical landmarks are important. From above downwards, the following structures can be felt in the middle line of the neck (Fig. 61) :—

1. The symphisis menti.
2. The median raphe of the mylo-hyoid muscles.
3. The body and the cornua of the hyoid bone.
4. The thyro-hyoid membrane, lying between the hyoid bone and the thyroid cartilage.
5. The body of the thyroid cartilage which has the notch above, the pomum Adami next (well marked in the male) and then its anterior border, which is distinctly palpable.
6. The crico-thyroid membrane lying between the thyroid and the cricoid cartilages.
7. The cricoid cartilage.
8. The first two or three rings of the trachea are between the lower border of the cricoid cartilage above and the isthmus of the thyroid gland below. These three can be indistinctly felt only in thin subjects on deep palpation.
9. The isthmus of the thyroid gland with the superior thyroid vessels on either side, encroaching by their terminations on to the middle line.
10. The supra-sternal notch.

The following operations are performed in the middle line of the neck :—

I. Pharyngotomy
{
(a) suprahyoid pharyngotomy.
(b) infrahyoid pharyngotomy, sub-
hyoid pharyngotomy (or
supra-thyroid laryngotomy).

II. Thyrotomy.

III. Laryngotomy.

IV. Tracheotomy $\{$ (a) high tracheotomy.
                      (b) low tracheotomy.

V. Thyroidectomy.

I. Pharyngotomy.

Indications.—This operation may have the following object in view :—

1. To get an access to the lower part of the posterior wall of the pharynx.

2. To remove growth from the epiglottis or upper part of the larynx.

3. To extract foreign bodies from the pharynx or upper part of the larynx.

(a) *Suprahyoid pharyngotomy* is performed in order to remove tumours at the base of the tongue or on the epiglottis. Make a transverse skin incision with concavity upwards just above the hyoid bone. Divide transversely mylo-hyoid and genio-hyoglossus muscles. Open the pharynx without injuring the epiglottis. This exposes the pharynx, soft palate, tonsils, epiglottis and the base of the tongue.

(b) *Infrahyoid pharyngotomy* (subhyoid pharyngotomy).

Position.—Dorsal position. Extend head by placing sandbags under neck and shoulder. The assistant steadies head, keeping the chin rigidly in the middle line of the body, so that the chin and the sternal notch are in a line. Stand on the left side of the body, facing the chin. Steady the larynx with left hand.

Instruments.—Group XI.

Operation.—Make a transverse cutaneous incision parallel to the hyoid bone and immediately below it. Divide in succession platysma, omo-hyoid and sterno-thyro-hyoid muscles and then the thyro-hyoid membrane leaving enough of these structures above and below in order to unite them by sutures. Divide the mucosa as it bulges through the wound

and retract its upper edge by means of a suture. Insert a suture into the epiglottis and pull it out. The larynx and pharynx are now exposed (Fig. 61).

II. Thyrotomy.

This operation allows free access to the vocal cords for the removal of tumours growing from them ; also foreign bodies impacted in the larynx may be readily extracted through this opening (Fig. 61).

III. Laryngotomy.

In this operation the larynx is opened by a transverse incision through the crico-thyroid membrane. This opening, by itself, allows only a small amount of room which is available between the cricoid and thyroid cartilages. So this operation is generally combined with tracheotomy by cutting through the cricoid cartilage and the first two rings of the trachea (laryngo-tracheotomy or laryngo-fissure).

Position.—As for infrahyoid pharyngotomy.

Instruments.—Group XI.

Operation.—Make a median vertical incision, skin and fascia deep, commencing at the middle of the thyroid cartilage. The interval between the sterno-thyroid and crico-thyroid muscles of either side is felt and widened. The crico-thyroid membrane which is now exposed is divided horizontally, directly above the upper border of the cricoid cartilage. This opens into the larynx. The laryngotomy tube which is shorter, of a sharper curve and flattened antero-posteriorly is introduced (Fig. 61).

Comment.—(1) Keep the knife rigidly in the middle line, to avoid injuring the crico-thyroid vessels. (2) Make sure that the larynx is properly opened before introducing the tube. It is not an uncommon mistake to pass the tube between the crico-thyroid membrane and the windpipe. (3) The operation has two advantages, the rapidity with which it can be performed and the ease with which it can be carried out. (4) It has,

however, certain disadvantages. It is not suitable for children owing to the narrowness of the crico-thyroid space and owing to the proximity of the vocal cords, they are liable to be injured unless a suitable tube is properly adjusted ; besides, it is very unsuitable for cases in which a tube has to be worn for a long time.

IV. Tracheotomy.

This is often an operation of emergency and may have to be performed at short notice. It is a simple operation on the dead subject but in the living it requires a thorough knowledge of its technique. Coolness, deliberation, dexterity and quickness have to be combined in order to make the operation a success.

Indications.—

A. For extrinsic conditions, i.e., conditions which cause partial or complete obliteration of the trachea due to pressure from without, causing respiratory difficulty (dyspnœa), *e.g.,* from (*i*) inflammatory conditions such as cellulitis of the neck (angina Ludovici) and retro-pharyngeal abscess ; (*ii*) pressure from (*a*) tumours (simple or malignant) in the neighbourhood of the trachea or larynx, (*b*) goitre, (*c*) aneurysm of the thoracic aorta and (*iii*) spasmodic conditions due to tetanus, nerve lesions, etc.

B. For intrinsic conditions including all conditions which give rise to respiratory difficulty, due to obstruction inside the larynx or in the lumen of the trachea. These may be enumerated as follows :—(*i*) Traumatic, such as (*a*) impaction of foreign bodies in the larynx or trachea, (*b*) cut-throat wounds and (*c*) inhalation of strong irritants giving rise to laryngitis. (*ii*) Inflammatory conditions such as (*a*) diphtheria, (*b*) certain types of croup, (*c*) acute septic laryngitis and (*d*) syphilitic and tubercular ulcerations. (*iii*) New growths simple or malignant of the larynx, *e.g.,* papillomata and epitheliomata.

C. As a preliminary measure to certain operations, *e.g.,* excision of the tongue or the jaws in order (*i*) to enable

PLATE XXI.

Suprathyroid laryngotomy= subhyoid pharyngotomy.

St. hyoid M.

Thyrotomy

Laryngotomy

High tracheotomy

Low tracheotomy

Rec. Lar. N.
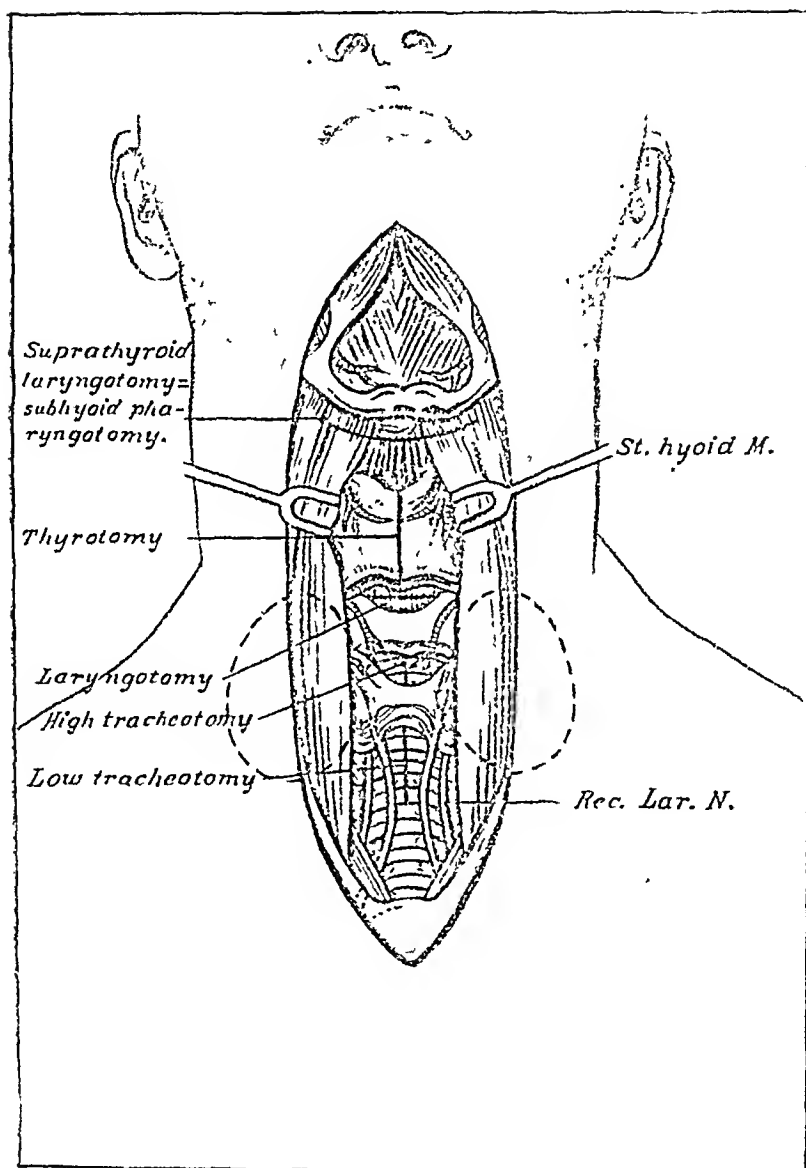
FIG. 61.
Operations in the middle line of the neck.

the operator to plug the larynx after tracheotomy and thus prevent aspiration pneumonia and (*ii*) to facilitate the administration of anæsthesia through the tracheal opening.

D. *For the extraction of foreign bodies* impacted in a situation proximal to the tracheotomy wound, or in the bronchi for inspection (through the tracheotomy wound) of the trachea or bronchi for foreign bodies or any pathological condition (tracheo-bronchoscopy).

The operations for tracheotomy can be " high " or " low," according to the position where the trachea is opened. High tracheotomy is the operation of choice ; low tracheotomy is only performed where it is specially indicated, as will be discussed later.

Position.—The patient is brought to the right edge of the table, his head hanging beyond the upper end. A sand-bag is placed under the neck. The neck is so extended that the vertex points almost towards the floor. This position has the following advantages :—(*a*) it steadies the trachea, (*b*) it draws as much of the trachea as possible into the neck, (*c*) it makes the upper part of the trachea more superficial and (*d*) it helps to empty the superficial veins. The operator stands on the right side of the table facing the trachea. The assistant stands at the head end of the table holding the head straight, in the same manner and with the same precautions as for pharyngotomy, described above.

Instruments.—Group X.

The tracheotomy tube should be of such construction as it may be easily introduced and manipulated. It should be of proper size, considering the age of the patient, *i.e.*, not too long to touch the posterior tracheal wall and not too broad in comparison with the diameter of the trachea.

A. High tracheotomy.

The trachea is opened between the cricoid cartilage above, and the isthmus of the thyroid gland below. This

operation should always be performed in preference to the low operation, for the following reasons :—

1. From above downwards the trachea slopes posteriorly and, therefore, the first part of the trachea is more superficially situated.

2. This part of the trachea is most fixed.

3. It can be made more accessible and tense, by extending the neck.

4. There are no large vessels or other important structures in its close proximity.

Operation.—The operation is described in three stages :—

1. Exposure of the trachea.

2. Opening of the trachea.

3. Introduction of the tube.

1. *Exposure of the trachea.* Define the cricoid cartilage accurately, steady the skin and trachea with left hand keeping the right hand free. Make an incision from the centre of the cricoid, precisely in the middle line of the neck vertically down for an inch to an inch and a half (Fig. 61). This incision cuts through the skin, subcutaneous fat and the anterior layer of the cervical fascia. This exposes the interval between the sterno-hyoid muscles on either side. Separate the muscles in the middle line by a fine dissector and dissection forceps. Divide carefully the deep cervical fascia (pretracheal layer) which is now exposed. The first two rings of the trachea and the isthmus of the thyroid gland are now exposed. Displace the isthmus downwards by the blunt hook. Look for the first two or three tracheal rings and feel them with your left forefinger.

2. *Opening the trachea.* Introduce the sharp hook into the cricoid cartilage and give it to the assistant who holds it precisely in the middle line, to fix and draw it forwards. (The hook should be allowed a certain amount of play with the movements of inspiration and expiration.) Take a short narrow-bladed scalpel and hold it with the sharp edge directed towards the chin, by the handle and *the blade* between your

forefinger and thumb, so that the portion of the blade beyond your thumb and forefinger is enough to stab the anterior wall of the trachea, but not long enough to reach its posterior wall. Stab the trachea from the third ring below in the middle line and cut up to the lower border of the cricoid.

3. *Introduction of the tube.* The cricoid is still held fixed by the assistant. Introduce the tracheal dilator into the opening and hold it open by the left hand. With the right hand introduce the outer female part of the tracheotomy tube. If it is a bivalve tube, compress it between the finger and thumb and introduce it. Remove the sharp and blunt hooks. Introduce the inner male tube. Some surgeons are in the habit of introducing both tubes at the same time.

Comment.—(1) Get your instruments together in one lot. This instruction cannot be more strongly emphasised than for this operation. (2) The positions of the operator, the assistant and the patient are of utmost importance. The neck should be completely extended and kept rigidly steady in the middle line throughout the operation. (3) Do not remove the sharp hook till the tube is introduced. (4) Divide the cervical fascia precisely and cleanly otherwise the tube may be introduced between the trachea and the fascia by mistake. (5) Satisfy yourself not only by seeing the white rings of the trachea but by feeling them. (6) In making the tracheal stab and cut, the knife should be well controlled as described. (7) In fat subjects the skin incision should necessarily be longer.

B. Low tracheotomy.

This operation is similar to that for high tracheotomy with the following differences :—

1. The incision is longer, reaching almost to the sternal notch.

2. It needs a deeper dissection.

3. The isthmus of the thyroid is retracted upwards.

4. The structures met with are practically the same but the veins are larger ; the inferior thyroid vein will need

division between two ligatures. The intermuscular line between the sterno-thyro-hyoid is less distinct (Fig. 61).

Indications.—The indications for this operation are only two :—

1. For disease involving the lower part of the larynx or upper part of the trachea.

2. As a preliminary measure to laryngectomy.

The disadvantages and risks attending this operation are many :—

1. The branches of veins are larger and thicker such as the inferior thyroid, etc.; the thyroidea-ima artery may also be in the field of operation.

2. Proximity of large blood vessels to it, *e.g.,* the *innominate artery and vein.*

3. In children the thymus gland is large and may complicate the operation.

4. The trachea is more mobile and cannot be steadied as in the high operation.

5. By the suction action of the chest, the trachea is more liable to be pulled back into the wound.

6. In case of accidental sepsis, the pus can be conducted into the mediastinum.

V. Thyroidectomy.

Indications.—(1) In order to remove a disfigurement. (2) When in spite of medical treatment the goitre is increasing in size. (3) When due to the position and size of the growth, pressure symptoms are produced such as respiratory difficulty, tracheal stridor, dyspnœa, circulatory disturbance and symptoms due to pressure on the nerves. (4) When there are evidences of its becoming malignant.

Operation.—Local anæsthesia is preferred and failing this local and general (mixed) anæsthesia should be employed. Various incisions have been described but Kocher's method is generally adopted. An incision is made transversely across

the most prominent part of the tumour.   The anterior border
of   the   sterno-mastoid is defined.   Sterno-hyoid and sterno-
thyroid   muscles are divided or widely separated by a blunt
dissector ; the goitre thus freed along its outer and posterior
aspects, the tumour is dislocated forward out of the wound.
The superior thyroid vessels are crushed in two places by
Kocher's clamps, secured and divided, the inferior thyroid
vessels   are also secured in the same manner avoiding the
recurrent laryngeal nerve.

   Comment.—(1) The chief danger of this operation is
hæmorrhage. (2) A   very large number of artery forceps
and clamps are required for this operation.   (3) The recurrent
laryngeal nerve must be avoided while ligaturing inferior
thyroid vessels.   (4) If one lobe of the thyroid is to be removed
the isthmus is caught between two pairs of Kocher's clamps and
crushed, ligatured and then divided.

CHAPTER XIV.

ABDOMINAL OPERATIONS.

Laparotomy : Celiotomy.—(Abdominal section.)

Surgical Anatomy.—The linea alba extends from the ensiform cartilage to the symphisis pubis in the middle line of the abdomen. On either side of this line are the recti muscles. The outer border of these muscles on either side are represented by two lines, linæ semilunares, slightly curved outwards. They extend from the seventh rib down to the spine of the pubis. In the umbilical line the distance between the linea alba and semilunares is about three inches.

The disposition of parietal layers in the space between the lineæ semilunares, taken from before backwards is as follows :— In the upper three-quarters are the external oblique, the anterior tendon of the internal oblique, the rectus, the posterior tendon of the internal oblique, the transversalis tendon, fascia transversalis, subperitoneal areolar tissue and peritoneum. In the lower quarter all the tendons pass in front of the rectus so the arrangements here would be, the tendon of the external oblique, internal oblique, the transversalis then the rectus muscle, transversalis fascia, the subperitoneal areolar tissue and peritoneum. Further out than this area, *i.e.*, beyond the lineæ semilunares, the layers of muscles of the parieties are arranged from before backwards as follows :—The external oblique, the internal oblique and transversalis, then the transversalis fascia, subperitoneal areolar tissue and the peritoneum.

The disposition of the fibres of the muscles are as follows :—The external oblique muscle has its fibres directed downwards and inwards. They are muscular above the level of the anterior superior iliac spine and are tendinous

below it. The fibres of the internal oblique are generally directed upwards and inwards with the exception of the portion which is below the level of anterior superior spine of the ilium. In this portion the fibres follow the direction of those of the transversalis muscle. The fibres of the transversalis muscle are directed transversely inwards towards the middle line except in the lower portion where in combination with lower fibres of the internal oblique they arch downwards and are inserted in the pubis.

The abdominal parieties are supplied by three groups of vessels, which anastomose freely with one another but slightly with those of the opposite side. Group I.—Running forwards are the two lower intercostals, the subcostal and the lumbar arteries. They lie between the transversalis and the internal oblique with the nerves. Group II.—The superior epigastric artery runs downwards and lies in the substance of rectus muscle. Group III.—The deep epigastric artery arises from the external iliac just above the Poupart's ligament, runs upwards and inwards to the inner side of internal abdominal ring and the spermatic cord to enter the sheath of the rectus. The deep circumflex iliac artery arises on the same level as the last one, runs upwards and outwards behind the Poupart's ligament, along the crest of the ilium, till it reaches the anterior superior iliac spine where it sends an ascending branch which lies between the internal oblique and transversalis.

Instruments.—Group XIII.

Positions of incisions.

1. *The median incision* above or below the umbilicus. Above the umbilicus the incision through the linea alba directly exposes transversalis fascia. Below the umbilicus on the other hand, the linea alba becomes an intermuscular septum between the two recti and the median incision exposes the edge of one or the other of these muscles. This is the classical method of opening the abdomen, but if precautions are not taken it is often followed by a ventral hernia.

2. *The para-median incision* is made at one or the other side of the median line. It exposes the anterior layer of the rectus sheath. The muscle is then split in the vertical direction exposing the posterior sheath. This is opened and the peritoneum reached in the usual way.

3. *The para-rectal incision* in the semilunar line divides the aponeurosis of the flat muscles above described in a direction which is against the fibres of the muscles. This is destructive to the muscle fibres as well as the nerves supplying the rectus and should be avoided whenever possible.

4. *An oblique incision* by a typical " muscle-splitting " method is very useful in the lower part of the abdomen. The skin is incised in the direction of the fibres of the external oblique. This muscle thus exposed is split between its fibres and retracted. The internal oblique which is now exposed is treated in a similar manner by splitting its fibres and the transversalis is opened with it. Thus the transversalis fascia is reached. This and the peritoneum are divided in the manner described above.

5. *For other methods* of opening the abdomen in other situations for special operation, larger text-books of operative surgery should be consulted.

Operation.—In opening the abdomen the following rules should be observed :—

1. The incision should be so placed that the object for which the operation is being performed is most easily attained.

2. Large (motor) nerves and blood-vessels should be avoided.

3. Whenever possible the muscles should be split between their fibres and not cut across. Blunt dissection with a dissector or the fingers is better than free use of the knife.

4. The different layers of the wall should be divided from end to end of the skin wound.

5. The transversalis fascia and the peritoneum are opened by picking them up with forceps, holding the knife in

the violin-bow position; these structures should be divided by cutting them between your fingers with blunt pointed scissors.

Closure of an abdominal wound. Three layers of sutures should be employed. The first layer approximates the peritoneal margins which may include the posterior rectus sheath, if the incision has been made through it. Interrupted or continuous sutures of some absorbable material is the best. The second layer passes through the linea alba, the sheath of the rectus or other aponeurosis, taking the transversalis fascia in the deeper part. The third layer apposes the integument. In other situations, the peritoneum is sutured by continuous stitches and the muscles and fascia in layers by interrupted stitches as described later.

Intestinal sutures.

In closing an opening in the intestine the mucous and the muscular walls should be first apposed, these should be inverted or invaginated into the lumen of the gut. This brings the contiguous serous coats together; the most important part in suturing consists in bringing the serous surfaces into an accurate and permanent apposition. This can be achieved in one of the following methods :—
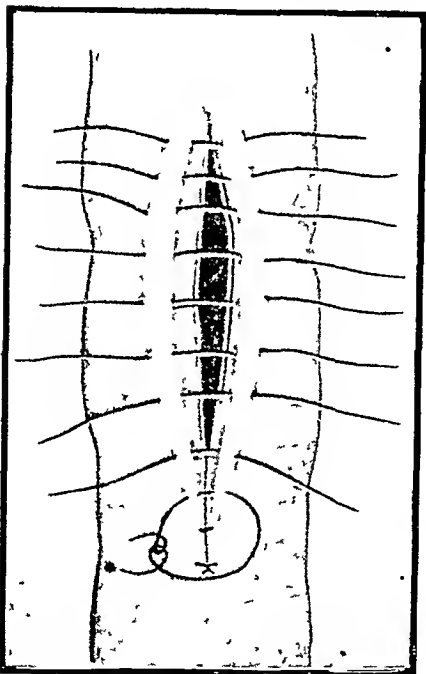
FIG. 62.
Lembert suture.

1. Lembert sutures.—This is an interrupted suture and introduced on the

transverse axis of the gut about one-eighth inch away from the cut margin and brought out again one-sixteenth inch from the same margin. This is then carried across to the opposite side of the wound, introduced at about one-sixteenth inch away from its margin and brought out again one-eighth inch from the same margin. These sutures pass through all the coats except the mucosa (Fig. 62).

2. **Czerny-Lembert sutures.**—In the Lembert suture the mucous and the muscular coats are not apposed separately ; in Czerny-Lembert method the mucous membrane is first united by a continuous suture and then the anastomosis is completed by Lembert sutures (Fig. 63).

3. **Dupuytren suture** consists of continuous Lembert sutures.

4. **Halstead suture** is a Lembert suture introduced in the mattress fashion (Fig. 62).

5. **Cushing suture** consists in passing the needle in the Lembert fashion but parallel to and not in a direction transverse to the long axis of the wound in the gut.
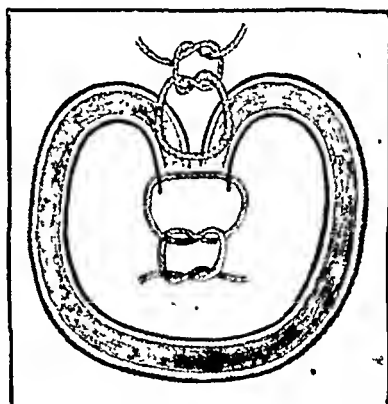
FIG. 63.
Czerny-Lembert suture.

6. **Purse-string suture** is used for, (i) drawing the intestine tightly round a Paul's tube or Murphy's button, (ii) invaginating the stump of the appendix after appendicectomy, (iii) closing an opening in the wall of a gut and (iv) closing the ends of the divided intestine. This suture is made by carrying a continuous Lembert (Dupuytren's) suture circularly round the entire circumference of the opening through the serous and muscular coats (Fig. 71). It is placed quarter inch to half an inch away from the central opening. The ligatured stump or central opening is pushed in while the purse-string suture is tightened by its free ends. This

invaginates the stump and closes the suture line concentrically on it, bringing the serous surfaces effectively into close apposition. Finally, the suture is secured by a double knot.

OPERATIONS ON THE STOMACH.

The following are the more common operations performed on the stomach:—

    A. Gastrotomy.
    B. Gastrostomy.
    C. Gastro-enterostomy.
    D. Pylorectomy.
    E. Gastrectomy.
    F. Pyloroplasty.
    G. Gastroplasty.

A. Gastrotomy, *i.e.,* opening the stomach with the object of removal of foreign bodies or exploration of the interior of the stomach and then closing it up. The stomach is exposed by a median incision through the abdominal parieties above the umbilicus. A small opening is at first made in the stomach wall for digital exploration. For the removal of foreign bodies or a complete inspection, the opening may be enlarged. To close it, a deep layer of sutures through all the coats is passed and then Lembert sutures for the sero-muscular layer.

Gastrotomy for simple inspection of mucous membrane of the stomach is rarely done now as for this purpose the gastroscope is used.

B. Gastrostomy consist in making a permanent opening into the stomach.

Indications.—(1) Obstruction of the œsophagus due to (*a*) malignant stricture, (*b*) cicatricial stricture of traumatic or syphilitic origin, (*c*) pressure of inoperable tumours, etc., from without. (2) Cancerous disease of the pharynx, tonsils and back of the tongue. (3) Obstruction due to stricture, etc., of the cardiac end of the stomach.

Several methods of gastrostomy are known, *viz.* :—

(1) Senn's operation. (2) Kader's operation. (3) Witzel's operation. (4) Frank and Albert's operation.

The last named method will be described.

Frank and Albert's method of gastrostomy.

Instruments.—Group XIV.

Position.—Place patient in dorsal position with a sandbag behind the trunk. Stand on the right side, the assistant stands opposite.

Operation.—Make an incision three inches long, skin and fascia deep, commencing from the level of the ensiform cartilage through the left rectus muscle. The anterior sheath of the rectus is exposed and divided. The fibres of the rectus muscles are separated and the posterior sheath is opened. The peritoneum and transversalis fascia with the subperitoneal fatty tissue is caught up with forceps and opened with a scalpel held in the violin-bow position. The opening is enlarged. This exposes the stomach. A conical pouch of its anterior wall is pulled up through the wound. The assistant supports the stomach by a pair of suitable forceps. Now proceed as follows :—Fix the stomach by a layer of sutures through its wall (on its right side) and the parietal peritoneum and transversalis fascia to the posterior sheath of the rectus. Make another incision about one inch long through the skin, subcutaneous tissue and the posterior sheath of the rectus, and an inch and a half above and external to the first incision. Introduce a pair of suitable forceps of Kocher type through this second incision towards the first one. The assistant now releases the stump which is seized with the forceps and pulled under the skin through the small (second) opening. Pass a few sutures through the sero-muscular coat of the stomach pouch and the margin of the second skin incision and close the abdominal wound in the usual way. Make an opening into the stomach after forty-eight hours. Pulling the stomach pouch under the skin causes a valvular

arrangement to the opening and prevents regurgitation of food.

C. Gastro-enterostomy.—This is a short circuiting between the stomach and the duodenum (gastro-duodenostomy) or the jejunum (gastro-jejunostomy) near its commencement. Gastro-duodenal anastomosis is rarely performed as the jejunum is more accessible and more easily manipulated. Most surgeons are of opinion that so long as the pyloric outlet is free the gastric contents pass in this direction even after gastro-jejunostomy has been performed. It is, therefore, questionable whether gastro-enterostomy will be successful when there is no obstruction to the normal gastric outflow.

Indications.—The operation is, therefore, indicated when normal passage of food through the pylorus is obstructed by pathological conditions. It is performed for the following conditions :—

1. Gastric and duodenal ulcers.

2. Pathological conditions resulting from these ulcers, *e.g.*, (*a*) pyloric stenosis due to cicatrisation, (*b*) perigastric adhesions interfering with the movements of the stomach and (*c*) hour-glass contraction of the stomach with a large cardiac and small pyloric pouch.

3. Congenital hypertrophic stenosis of the pylorus.

4. In inoperable cancer of the stomach as a palliative measure.

5. As a preliminary measure to the operation of gastrectomy.

The jejunum can be anastomosed either to the anterior wall (anterior gastro-jejunostomy) or to the posterior wall (posterior gastro-jejunostomy). There are certain objections to the former :—

1. The loop of jejunum has to be brought up in front of the transverse colon in order to reach the anterior wall of the stomach and this loop presses on the colon.

2. The drainage through the communication is not free.

3. A vicious circle, *i.e.*, the return of the stomach contents from the jejunum back into the stomach, is more common after the anterior than after the posterior operation.

From these considerations, posterior gastro-jejunostomy is the operation of choice and will be described.

Posterior gastro-jejunostomy.

Instruments.—Group XIV.

Position.—Same as for previous operation.

Operation.—1. *The parietal incision.*—A vertical incision about four inches in length is made slightly to the right of the middle line. The various strata are divided as for the operation of gastrostomy.

2. *Exposure of the stomach.*—The most dependent part of the stomach is identified. The stomach with the transverse colon and the greater omentum is lifted out of the abdomen and turned up on the lower part of the chest-wall. This brings into view the transverse meso-colon, which passes from the transverse colon to the posterior abdominal wall and hides the posterior wall of the stomach from view. A non-vascular area in the meso-colon is selected and an opening is made in it with a pair of scissors and enlarged with fingers. Thus the lesser peritoneal sac and the posterior wall of the stomach are exposed to view. The stomach is drawn out through the meso-colic aperture and its dependent part noted. A fold of the gastric wall from this part is raised and grasped with a suitable clamp in such a way that their tips point towards the right shoulder and the handles to the left hip of the patient.

3. *Exposure of the jejunum.*—Pass fingers along the root of the transverse meso-colon, the first loop of intestine on the left of the spine is the duodeno-jejunal flexure which can be identified by its firm attachment to the posterior abdominal wall. Draw out a loop of jejunum about six to eight inches from the flexure and clamp it in a similar way, keeping the tips of the blades towards the right shoulder.

4. *The anastomosis.*—Only the stomach and the jejunum held by the clamps are kept outside the wound, the rest being returned to the abdomen. The clamps are brought along side each other and approximated for suturing. (The tips of all four blades are pointing towards the shoulder.) The anastomosis is now carried out as in lateral intestinal anastomosis in the following manner (Figs. 64, 65 and 66) :—

(*a*) The posterior line of sero-muscular suture consists of non-penetrating Dupuytren's continuous suture for three inches, carried from left to right and about a quarter of an inch away from the future line of anastomotic opening. Leave a long tail to the thread at its commencement on the left and the needle still threaded at the right end.

(*b*) Opening the stomach and jejunum. Open the stomach one-fourth inch from and parallel to the line of above suture in such a way, that this incision falls short of the suture line by one-third inch at each extremity. The incision should go through all the coats but the mucous membrane. Now, pick up the mucous membrane and remove an elliptical portion of it with a pair of scissors. The jejunal opening is made in a similar way.

(*c*) Suture of the margins of the gastric and jejunal openings. This is accomplished by a layer of continuous suture penetrating all the coats of stomach and jejunum. Commence at the left and proceed towards the right connecting the posterior margin of the aperture ; then continue the suture back from right to left connecting the anterior margin. On reaching the starting point tie off the two ends of the thread with a knot. At any doubtful spot put one or two independent sutures, particularly at the two far ends where the sutures turn.

(*d*) The anterior line of the sero-muscular suture. Remove the clamps. Pick up the threaded needle left at the right end of the sero-muscular suture and carry a similar suture back to the left, to its starting point and tie it off

securely with a knot. Make a careful inspection of the suture line and supplement it with a suture here and there in case of doubt. This suture inverts the inner penetrating line of sutures.

5. *Closure of the meso colic aperture.*—Pass a few sutures closing the meso-colic aperture and connect it to the jejunum close to its junction with the stomach.

6. *Closure of the abdominal wall.*—The anastomosed stomach and jejunum are returned into the abdomen and the parietal wound closed in the way already described. (*Vide supra*).

D. & E. Pylorectomy and Gastrectomy.—These operations are occasionally performed in cases of early stages of malignant disease of stomach or pylorus. These are, however, practically given up as such cases, when they come to the surgeon, are gone too far, due to the extension of the disease, formation of adhesions and involvement of glands.

F. Pyloroplasty is an operation devised by Finney and others for stenosis of the pyloric orifice, due to cicatrisation of a healed gastric ulcer.

G. Gastroplasty is a similar operation to above, for relieving hour-glass constriction of the stomach. These operations have been greatly superseded by gastro-enterostomy as even after this elaborate operative measure the conditions recur.

CHAPTER XV.

INTESTINAL ANASTOMOSIS.

Indications.—One part of the intestine is joined to another in the following conditions :—

1. In order to bring about short-circuiting of the intestinal contents by excluding an obstructed portion of the gut. A part of the intestine proximal to the obstruction is opened and connected to a similar opening in the intestine distal to the obstruction. This is generally done in cases of obstruction to the passage of the contents due to adhesions, kinking tumours, etc.

2. In cases where a portion of the intestine has to be resected, the proximal and distal cut ends of the gut are shut off by sutures, and lateral anastomosis is then performed. The indications for resection of intestine are :—(a) Gangrene due to strangulation, external or internal. (b) Wounds of the intestine due to gunshot, stabs, etc., or severe trans-parietal contusions of the gut. (c) Strictures of the intestine. (d) New growths. (e) Irreducible intussusceptions. (f) Some cases of volvulus. (g) Mesenteric growths. (h) For the cure of certain cases of fœcal fistula and artificial anus.

Intestinal anastomosis can be performed by one of the following methods :—

1. Lateral anastomosis.
2. End-to-end anastomosis.
3. End-to-side anastomosis or termino-lateral junction.
4. Anastomosis by means of artificial appliances.

I. Lateral intestinal anastomosis.—Two conditions are necessary, *viz.*, the portions of intestine to be united should be freely movable and the waves of peristalsis should be in the same direction, *i.e.*, they should be iso-peristaltic.

Instruments.—Group XIII.

Operation.—This can be described in five stages :—

1. *Approximation.*—Bring the loop of the gut outside the parietal wound ; place them together in iso-peristaltic direction. Squeeze out the contents and apply intestinal clamps to keep them empty for about five inches.

2. *Posterior sero-muscular suture.*—Unite the loops by Cushing or continuous Lembert sutures parallel to and not far from the mesenteric border and leave the tail end of the thread long and the other end with the needle still threaded (Fig. 64).
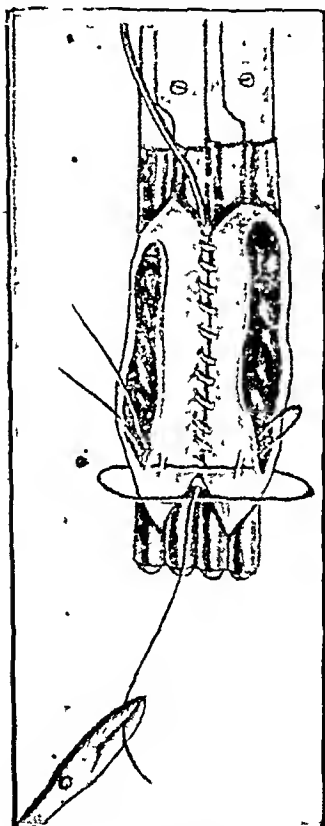
FIG. 64.
Posterior sero-muscular suture.
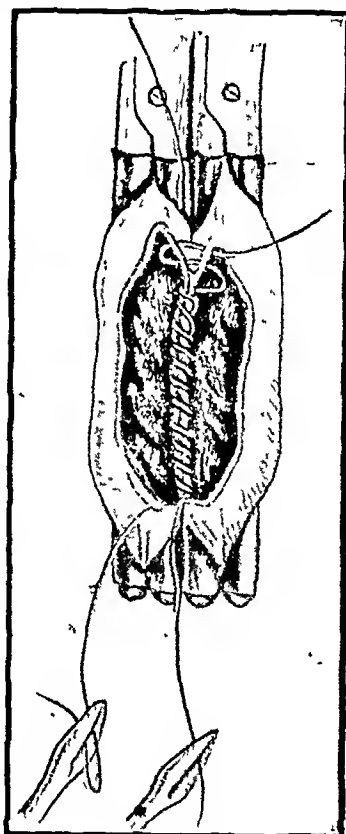
FIG. 65.
Through-and-through suture.

3. *Opening the gut.*—Make openings in the loops an inch shorter than the sutures and at a safe distance from them (Fig. 64).

4. *Intestinal junction.*—Unite the corresponding cut edges in the gut by continuous sutures taking in all the coats (Fig. 65).

5. *Anterior sero-muscular suture and completion of anastomosis.*—Continue the posterior row of Cushing or Lembert sutures completely round the site of the anastomosis. (Fig. 66.)
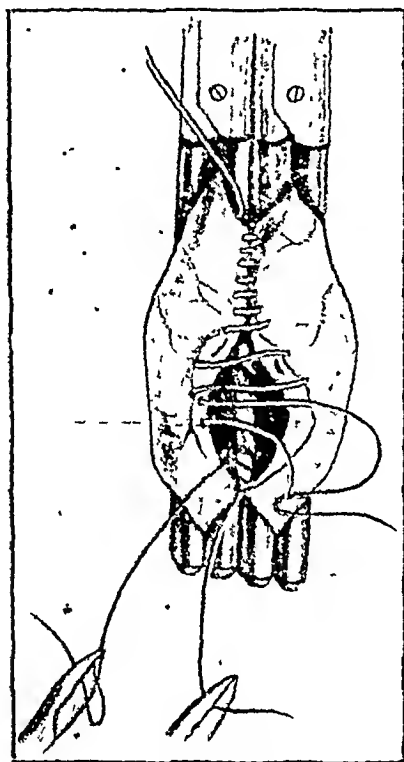
FIG. 66.
Anterior sero-muscular suture.

6. *Examine the line of sutures*, put-one or two sutures in doubtful spots, remove the clamps and return the gut into the abdomen.

II. End-to-end anastomosis.—In this method the two cut ends are brought together and sutured.

Instruments.—As for previous operation.

Operation.—The portion of the gut is brought out of the abdominal wound and clamped.

1. *Mesenteric section.*—A V-shaped portion of the mesentery is marked out. The apex of the V is ligatured and tied, taking care not to obstruct the arterial supply to the mesentery. The V-shaped portion of the mesentery is now excised after ligaturing a few more smaller vessels.

2. *Resection of the gut.*—The gut is now divided on each side near the clamp in a slightly oblique fashion, so that more is removed from its convex than its mesenteric border.

3. *The intestinal junction.*—The open extremeties of the gut are brought alongside each other. The first line of

suture penetrates all the coats of the bowel close to the cut margin. This is done by a continuous suture running round the entire circumference of the gut. Care should be taken in approximating the portion of the gut which has mesenteric attachments to provide against any leakage. Remove the clamps. Any unsecured vessels may be controlled by an additional under-running stitch.

4. *The sero-muscular suture.*—This is a continuous sero-muscular Cushing suture and includes the adjacent layers of the mesentery which may have formed a triangular gap at the mesenteric border. This inverts the first line of suture and brings the serous surfaces into contact.

5. A *non-penetrating suture* may then be taken all round the bowel.

III. End-to-side, endo-lateral anastomosis or termino-lateral junction.—The open extremity of the lower (distal) segment is closed and the proximal segment is implanted into a lateral opening in a distal portion lower down.

IV. Anastomosis by means of artificial appliances.—Various appliances have been devised with a view to facilitate the junction of divided segments of the bowel such as Murphy's button, bone rings, bobbins, etc.

Murphy's button consists of two halves; the male half is heavier the two as it contains a spring and a flange; this should always be inserted into the distal part of the intestine to facilitate its escape with fæces. Purse-string sutures are inserted round the divided ends of the gut. The female half of the button is introduced into the proximal end of the intestine and the suture is pulled tight and tied. The male half is likewise fixed into the distal end of the gut. The two halves of the button are then pushed together gently and steadily till they are clamped. A few supporting Lembert sutures may be introduced round the button.

Comment.—Comparison of the merits of different methods of anastomosis.

(*a*) Lateral anastomosis is preferred for the following reasons :—

1. The union is made through a part of the bowel which has complete peritoneal covering and therefore ensures strong and early adhesions.

2. The incision in the bowel is made at some distance from its mesenteric attachment and therefore bleeding is slight and circulation of the intestine is not interfered with.

3. It is easy to perform, particularly, if it is done by Halstead's method.

4. The avoidance of the mesenteric border of the bowel obviated any risk of extravasation.

5. The opening in the bowel can be made of considerable length and therefore there is a better channel of communication between the proximal and distal ends.

(*b*) End-to-end anastomosis has certain disadvantages :—

1. Nearly half an inch of the circumference of the gut at the mesenteric attachment is devoid of peritoneum, consequently this is a weak point in the union.

2. Stricture is more likely to result.

3. It is more difficult to perform.

4. If a portion of small intestine, which has a smaller calibre, is to be united to the colon which has a larger calibre the operation is still more complicated.

(*c*) Murphy's button method has the following objections :—

1. The apposed surfaces may get gangrenous and the button may perforate through the wall of the gut.

2. The opening, left after the Murphy's button has travelled down, may become very small or even disappear.

3. The button after having got loose may get impacted lower down especially at the ileo-cœcal valve causing intestinal obstruction.

The only point in its favour is the rapidity with which operation can be performed.

CHAPTER XVI.

APPENDICECTOMY.

Surgical Anatomy.—The vermiform appendix is a narrow blind tube, arising from the inner and back part of the cœcum about three-fourths of an inch below the ileocœcal junction. Its length varies from an inch to nine inches; generally, it is three to three and a half inches long. It is completely covered by peritoneum and has a mesentery—the meso-appendix. The appendicular artery runs near the free border of the mesentery which does not in all cases extend to the tip of the appendix.

Surface Marking.—McBurney's point is represented by a point at a junction of the outer and middle thirds of a line drawn from the right anterior superior iliac spine to the umbilicus. This is the usual seat of maximum pain on palpation during an attack of appendicitis. This, however, does not coincide with the anatomical position of the cœcal orifice of the appendix. It may be more accurately located by a point where the inter-tubercular (the line joining the tubercles of the crests of the illia) and mid-Poupart lines intersect. This is the usual situation of the orifice, but the appendix can be found in any of the following situations :—(1) Curling upwards and inwards, under cover of the lower end of the ileum. This is the commonest situation of the appendix. (2) Hanging downwards, over the brim of the pelvis. (3) Directed upwards, behind and towards the outer side of the cœcum.

Instruments.—Group XV.

Operation.—

1. *The parietal incision.*—Various forms of incision have been devised for reaching the appendix. Two objects

must be in view, *viz.*, providing a good access to the iliac
fossa and inflicting minimum damage to the muscles and
nerves of the abdominal wall. McBurney's muscle-splitting
method (Fig. 67), or the gridiron incision fulfils the above
two conditions. It has been complained that this method
does not allow sufficient room, particularly, if the appendix
is not in the first of the three situations. The incision
can, however, be extended and the patient placed in the
Trendelenburg position to overcome this difficulty. Battle's
para-rectal incision, in a vertical direction, about an
inch internal to the right semilunar line, is useful when
the exact position of the appendix has not been previously
ascertained.

Make a three inch incision skin deep, in the direction
of the fibres of the external oblique aponeurosis, its mid-point
being situated about one an half inch above, and to the outer
side of McBurney's point. This exposes the external oblique.
Separate the fibres of this muscle for the whole length of the
wound by blunt dissection and retract its edges. This exposes
the internal oblique and transversalis whose fibres are in a
direction at right angles to the skin wound. The fibres of
these muscles are separated in a similar manner. The trans-
versalis fascia and peritoneum are picked up between two
pairs of forceps and a small opening is made with a knife
holding it in the violin-bow position (Fig. 3). The opening
is then enlarged by a pair of scissors using two fingers as a
guide (Fig. 67).

2. *Isolation and delivery of the appendix.*—The colon
is sought for by digital exploration, sweeping the finger
round the iliac fossa. It is recognised by the longitudinal
muscular bands—the tæniæ coli, and appendices epiploicæ.
If the anterior band of muscular fibres be followed it will
lead to the appendix. The appendix is pulled out of the
wound. If there is difficulty in finding the appendix, enlarge
the wound so that the eyes may aid in the exploration
(Fig. 68).

PLATE XXII.

Appendicectomy.
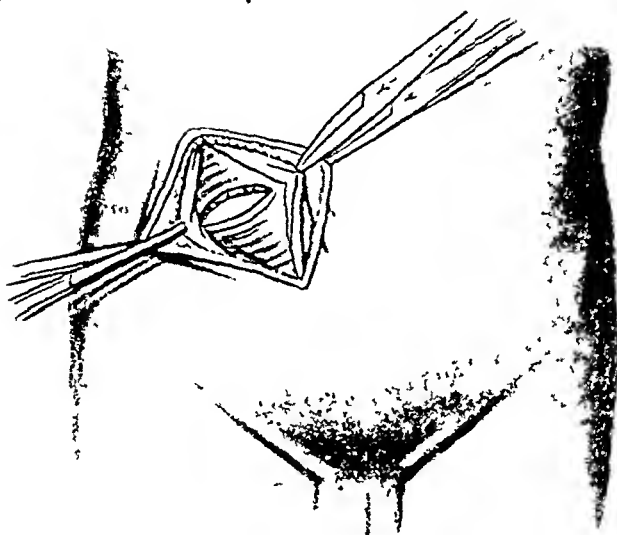
FIG. 67.

Muscle-splitting abdominal incision.
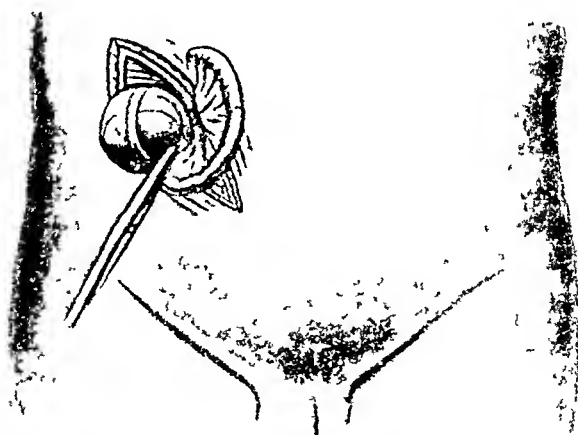
FIG. 68.

Cæcum and appendix drawn out.

3. *Section of the meso-appendix.*—The appendix with a portion of the cæcum having been drawn out through the wound, the meso-appendix is made tense and one or two sutures are inserted into it in the manner shown (Fig. 69). The meso-appendix is divided with scissors along its attachment to the appendix (Fig. 69).

4. *Removal of the appendix and treatment of the stump.*— The appendix is seized close to the cæcum with hæmostatic forceps or a crushing clamp (Fig. 70). All the layers are crushed but the serous coat. The clamp is removed and the crushed portion secured by ligature (Fig. 71). The appendix is cut across at the distal end of the ligature. The stump is invaginated by means of purse-string suture. It is best to put in a couple of interrupted Lembert sutures to make the sealing off secure (Fig. 72). Inspect the gut for any hæmorrhage and return it into the abdominal cavity.

5. *Closure of the abdominal wound.*—The abdominal wound is closed in four layers, the first line of sutures is for the peritoneum and transversalis fascia, the second for the transversalis and internal oblique muscles, the third for external oblique muscles and the fourth for the skin and superficial fascia.

PLATE XXIII.
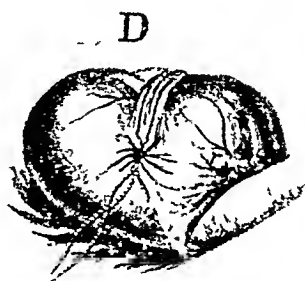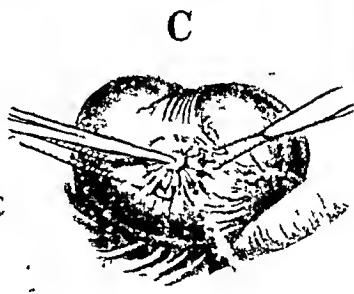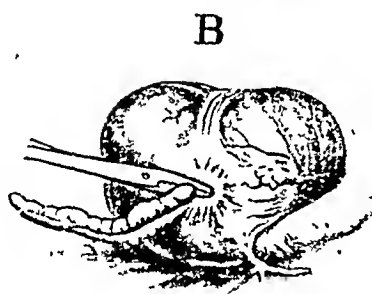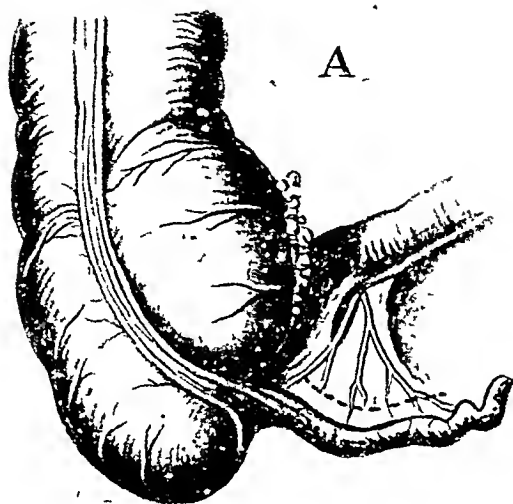
CHAPTER XVII.

COLOSTOMY.

THE colon is brought out through an abdominal wound and an opening is made into it for the passage of fæces.

Indications.—

1. Malignant disease of the colon or rectum.

2. Stricture of the rectum.

3. Recto-vesical fistula.

4. Certain forms of colitis.

5. Certain forms of congenital malformations of the rectum and anus.

6. As a preliminary or palliative measure in certain cases of malignant disease of the colon or rectum, giving rise to signs of obstruction.

7. Cases of obstruction of the colon due to kinking by bands such as by costo-colic ligament.

Inguinal or iliac colostomy.—The abdomen is opened in the left iliac region ; the pelvic colon is identified and the point of junction with iliac colon having been found, it is drawn out in the form of a loop sharply bent upon itself. It is then secured in the wound. It is important that the intestinal contents should not pass on into the part of the intestine distal to the opening. The contents should flow freely through the artificial opening.

Operation.—

1. *The parietal incision* is made on the left side and corresponds in its direction to that employed for exposing the appendix on the right side, *i.e.*, by McBurney's muscle-splitting or gridiron method (Fig. 67). The length of the incision should be from two to two and a half inches.

2. *Exploration for the colon.*—A distended colon may be easily found on digital exploration. Sometimes, however, the small gut or the great-omentum may cover it. Sweep the fingers from without inwards along the floor of the iliac fossa and get hold of the fixed portion of the intestine, this is the iliac colon. Follow this downwards, toward the brim of the true pelvis and find out the pelvic colon which can be recognised by the tæniæ coli, the sacculations and the appendices epiploicæ. Now deliver the pelvic colon out of the wound.

3 *Fixing the colon.*—A small aperture is made in the meso-colon avoiding any blood-vessels running in it. A glass rod is passed through the aperture and allowed to rest on the abdominal wall to support the gut. A curved needle, threaded with silk, is introduced about half an inch to an inch from one edge of the abdominal wound about its middle. It traverses the whole thickness of the abdominal wall from the skin to the peritoneum and passes through the meso-colon at a selected spot, free from vessels ; it is then carried through the corresponding point on the other side of the abdominal wound passing through its wall from peritoneum to skin. The needle now returns through the same opening in the meso-colon without traversing the abdominal wall. The two ends of the thread are therefore on the same side of the abdominal wound. The glass rod is removed. Two pieces of rubber tubing are introduced through the anterior and posterior threads of silk, the threads pulled tight and knotted (Ward stitch).

4. *Opening the colon.*—If the need for opening the colon is urgent, the gut is opened, a purse-string suture applied, a Paul's tube introduced, and the suture tightened. If the case is not so urgent, three or four days may be allowed to form adhesions and the gut opened either by an incision on its convexity or by excising a portion of the loop.

Comment.—(1) The parietal wound should be as small as possible, *i.e.*, just enough to permit the bowel being drawn

through. (2) Open the gut at the highest part. (3) The gut should be so fixed that a spur is made out of the posterior wall of the intestine which will prevent the fæces from passing on to the distal part of the opening.

Colostomy can also be perfomed on the right side—right inguinal colostomy or ascending colostomy or in the lumbar region—lumbar colostomy or the transverse colon may be opened anteriorly near the umbilicus—transverse colostomy.

Ascending colostomy.—An opening is made in the ascending colon on the right side. Some difficulty will· be encountered in drawing the bowel forwards, unless as it occasionally happens it is provided with a mesentery.

CHAPTER XVIII.

OPERATIONS ON THE LIVER AND GALL-BLADDER.

Surgical Anatomy.—The right lobe of liver cannot be palpated excepting its lower edge which can be felt sightly below the costal margin in the standing posture, but it cannot be felt in the recumbent position. The left lobe of the liver intervenes between the stomach and the anterior abdominal wall and as such it can be palpated in the left hypochondrium. The falciform or suspensory ligament divides the subphrenic space into two compartments, and accumulation of pus in these compartments are accordingly called right and left subphrenic abscess. On percussion the liver dulness reaches the level of the fourth intercostal space in the mammary line. The inferior surface of the right lobe is in relation with important structures, namely, the hepatic flexure of the colon, the duodenum at the junction of its first and second portions, the right kidney and suprarenal capsule. Access to the liver can be obtained by the following routes : (*i*) subcostal or pararectal route for its lower margin and inferior surface ; (*ii*) by dividing the costal cartilages below the reflection of the pleura (eighth to eleventh) to the upper aspect of the liver ; (*iii*) the transpleural route after dividing the ribs, pleura and diaphragm to the convex surface of the liver (Fig. 92).

The gall-bladder, bile-ducts and blood vessels are on the inferior surface of the liver. The fundus of ·the gall-bladder projects slightly beyond the free margin of the liver in a line with ninth or tenth right costal cartilage. The cystic duct joins the hepatic duct to form common bile-duct. The hepatic duct formed by the junction of a branch from each lobe and

issuing through the transverse fissure of the liver descends within gastro-hepatic omentum, to join the cystic duct thus forming the common bile-duct (ductus communis choledochus). In the gastro-hepatic omentum the hepatic vein is intermediate and slightly posterior in position with its artery to its left and the duct to its right. The duct passes behind the first part of duodenum and then on the inner and posterior aspect of second part where it is in close relation to the head of the pancreas ; along with the pancreatic duct, it perforates the muscular coat of the duodenum and opens into it by a common orifice. This duct is dilated just behind the orifice forming the ampulla of Vater which is a common site for the lodgment of gall-stones.

Operations on the liver.—

Operations for the treatment of abscesses of the liver (*vide* infra).

Operations on the gall-bladder.—

The following operations are commonly performed on the gall-bladder :—

I. Cholecystotomy or cholecystendysis.—

In this the gall-bladder is opened either for exploration or removal of stones and the opening then closed. As in these cases the gall-bladder is more or less infected or diseased, it is either drained (cholecystostomy) or excised (cholecystectomy).

II. Cholecystostomy.—

The gall-bladder is opened, fixed to the abdominal wound by stitches and drained.

Instruments.—Group XIX

Indications.—The indications for cholecystostomy may be summarised as follows :—

A. *For inflammatory and other conditions :*

1. When the gall-bladder is unhealthy, (*a*) hydrops, and (*b*) empyema of the gall-bladder.

2. When the gall-bladder is infected ; (*a*) infective cholecystitis ; (*b*) phlegmonous or gangrenous cholecystitis with or without perforation, when the patient's general

condition is too low for more radical measures ; (*c*) secondary infective pancreatitis.

B. *For traumatic rupture of the gall-bladder.*

C. *For gall-stones :*

1. In the gall-bladder and it has to be drained after their removal ₍cholelithotomy₎.

2. In the cystic duct when it is healthy and patent.

3. In the common duct when it is healthy and patent.

D. *As a palliative measure* in cases of cancer of the common duct or of the head of the pancreas causing mechanical obstruction to the flow of bile.

III. Cholecystectomy.—

The gall-bladder is dissected off the under-surface of the liver and removed after division of the cystic duct between two ligatures.

Indications.—Resection of the gall-bladder may be undertaken for the following conditions when the general condition of a patient admits of this operation :—

1. Empyœma of the gall-bladder.

2. Phlegmonous or gangrenous cholecystitis.

3. Ulcerative perforation of the gall-bladder.

4. Cicatricial structure of the cystic duct with dilatation of the gall-bladder.

5. Biliary fistula of the gall-bladder caused by stricture or otherwise which cannot be closed by plastic operation.

6. Contraction and distortion of the gall-bladder resulting from recurrent cholecystitis.

7. Traumatic rupture of the gall-bladder due to gun-shot and other injuries.

8. Malignant growth of gall-bladder when the disease is localised.

IV. Cholecystenterostomy.—

By this is meant the establishment of an anastomosis between the small intestine and the fundus of the gall-bladder by suturing or by introducing Murphy's button.

Indications. --

1. Irremediable obstruction of the common bile-duct.

2. A persistent biliary fistula (after operations on the gall-bladder or due to stricture).

3. Some cases of cholecystitis.

4. Chronic pancreatitis.

5. Obstruction of the common duct due to malignant disease of the head of the pancreas.

V. Choledochotomy.—

Opening of the common bile-duct to relieve obstruction due to impacted gall-stones or other causes. When a stone is removed after opening the duct it is called choledocho-lithotomy. The common bile-duct can be opened in two situations :—

(a) It can be opened in its supra-duodenal stage and the impacted stone can be slipped into that part from below and removed through this opening. This part of the duct is more easily accessible. This operation is called supra-duodenal choledochotomy.

(b) When the calculus is impacted too low down and it cannot be dislodged, the duct will have to be opened in its retro-duodenal portion. This operation is called retro-duodenal choledochotomy.

In the dead subject the gall-bladder is small and bound down under the liver, so it is difficult to perform an operation on such a gall-bladder. It can, however, be exposed and any of the above operations attempted if possible.

Exposure of the gall-bladder.—

The gall-bladder can be exposed by various incisions. Each method claims its superiority over others. Three methods will be described :—

1. A vertical incision in the linea semilunaris about three inches long just below the tip of the ninth costal cartilage on the right side.

2. Kocher's incision. This is an oblique incision about four inches long, an inch and a half below the right costal margin. It commences over the right rectus muscle near the middle line and is carried obliquely downwards and outwards parallel to the costal margin. The abdomen is opened. The upper edge of the wound is raised up with the costal margin and the lower edge retracted downwards. The round ligament extending from the umbilicus to the umbilical fissure in the lower margin of the liver is seen ; the gall-bladder is found on the right side of the ligament projecting from under the liver.

3. Draw a vertical line from the middle of the right Poupart's ligament upwards ; the point where this line cuts the lower margin of the costal arch (at the right ninth costal cartilage) is considered by some as the position of the gall-bladder. An incision on this line will expose it.

CHAPTER XIX.

INGUINAL HERNIA.

Operations on inguinal hernia.

Surgical Anatomy.—Poupart's ligament which is the lower part of the aponeurosis of the external oblique muscle, is attached to the anterior superior iliac spine externally and the spine of the os pubis internally. The external abdominal ring (the superficial crural arch) is a deficiency in this aponeurosis and is situated immediately above the crest of the pubis. The internal oblique muscle is attached to the outer half of Poupart's ligament, but in its inner half, it arches upwards away from it and gains insertion at its inner end into the crest of the pubis, and the sheath of the rectus muscle. The transversalis muscle lies deeper to it and the transversalis fascia is still on a deeper plane. The conjoined tendon of the internal oblique and transversalis muscles at its insertion into the pubic crest and ilio-pectineal line, lies behind the external abdominal ring. The internal abdominal ring (the deep crural arch) is an opening in the transversalis fascia and is situated half an inch above the middle of Poupart's ligament.

The spermatic cord in the male escapes through the abdominal ring, lies in the inguinal canal, passes through the external abdominal ring and enters the scrotum. The inguinal canal is represented by a line joining the internal and external abdominal rings and is about two inches long. The deep epigastric artery is represented by a line drawn from the inner border of the internal abdominal ring to the middle of the rectus muscle at about the umbilicus. An oblique inguinal hernia takes the same course as the spermatic cord and generally lies in front of it. A sac of hernia is a

process of peritoneum in which the abdominal contents (the hernia) protrude. Taking from before backwards the structures forming the abdominal wall in the region of the inguinal canal are as follows :—Skin, superficial fascia, intercolumnar fascia formed by the external oblique, cremasteric fascia formed by the internal oblique, aponeurosis of the transversalis (occasionally), infundibuliform fascia formed by the transversalis fascia, subserous areolar tissue and peritoneum.

In practice, however, while performing herniotomy, these different layers can hardly be distinguished as they are matted together. In the dead subject where there is no hernia, the different layers can be more readily demonstrated. These layers are called the coverings of an inguinal hernia.

The operation for radical cure of hernia or herniotomy has three objects in view :—First, a complete obliteration of the hernial sac, secondly, the reconstruction of the normal obliquity and valvular character of the inguinal canal, and thirdly, strengthening the anterior abdominal wall in the region of the inguinal canal and the two rings.

Indications.—

1. Inguinal herniæ in patients belonging to the labouring classes.

2. Such herniæ as cannot be satisfactorily controlled by trusses.

3. Irreducible herniæ.

4. Herniæ threatening strangulation or already strangulated.

5. Herniæ associated with ectopia testis.

6. With individuals who find difficulty in carrying on their ordinary vocations due to existing herniæ.

7. In order to obtain physical fitness for public services.

Instruments.—Group XVII.

Operation.—Different surgeons have devised different methods of operation, each claiming to obtain the three objects

described above more satisfactorily than others. The following among the many methods of operation, will be described :—

1. Bassini's method.
2. Halstead's method.
3. Author's modification of Bassini-Halstead method.
4. Kocher's method.
5. Macewen's method.

I. Bassini's method.

1. *Skin incision.*—An incision about four inches long, commencing a little external to the middle of Poupart's ligament and an inch above it, is carried downwards and inwards towards the external ring. This divides the skin and fascia and exposes the external oblique aponeurosis (Fig. 73).

2. *Division of the external oblique.*—This aponeurosis is divided, commencing from its opening at the external abdominal ring upwards, for the whole extent of the skin wound. The cut margins are caught with forceps and the aponeurosis is raised above and below in the form of two flaps. Retract the flaps. Now define the conjoined tendon, the Poupart's ligament and the internal oblique muscle (Fig. 74).

3. *Isolation of the hernial sac.*—A mass of tissue is now exposed : these consist of the spermatic cord with an investment of the cremaster muscle, the transversalis fascia and the hernial sac. The sac is more or less blended with the other tissues. Catch the fundus of the sac with a pair of forceps and isolate it from the surrounding structures with the finger covered with gauze or by blunt dissection and light touches of the knife. When the sac is isolated up to the level of the parietal peritoneum, open its fundus and inspect inside for its contents or adhesions. Return contents into the peritoneal cavity and separate adhesions carefully if any (Fig. 75).

4. *Excision of the sac.*—Apply a clamp on the sac at the level of the parietal peritoneum ; transfix it with a needle

PLATE XXIV.
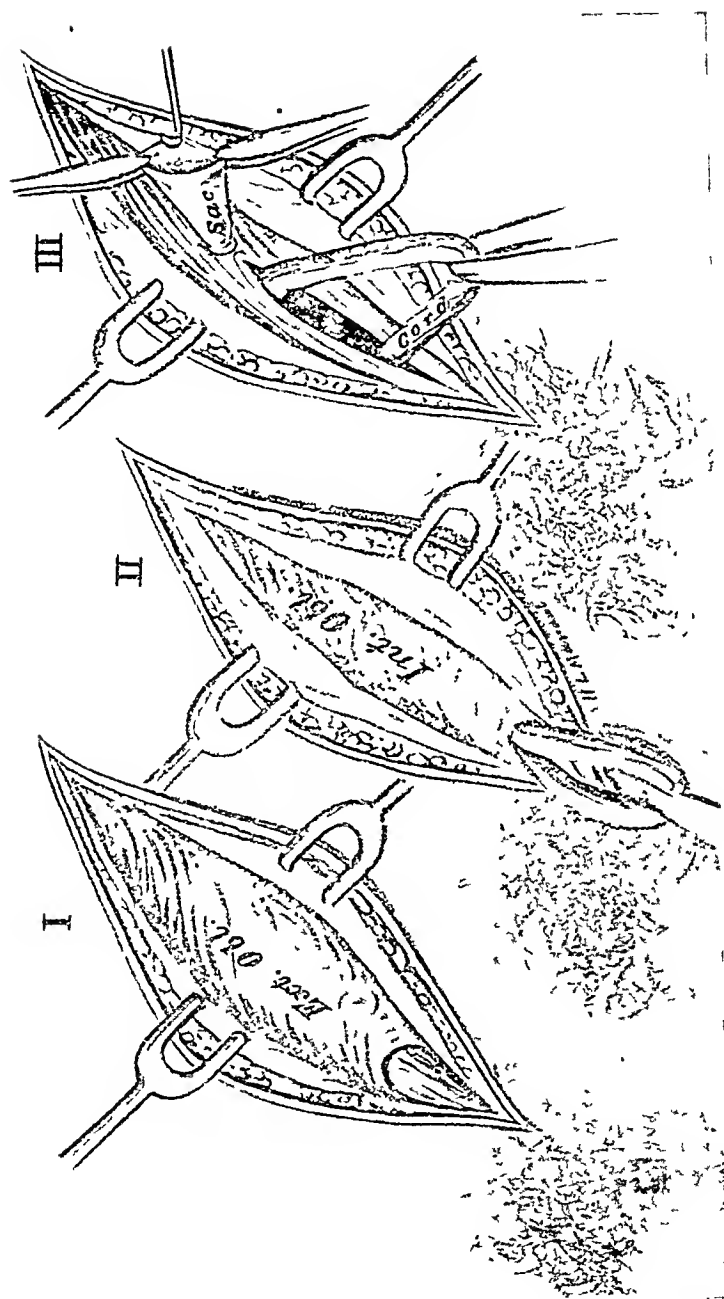
FIG. 73.

FIG. 74.

Bassini's operation for hernia.

FIG. 75.

and ligature it. Remove the fundus of the sac beyond the ligature. Let the stump of the sac retract into the abdominal cavity. Put a finger into the internal ring to make sure that the stump is free in the abdominal cavity.

5. *Suture of the internal oblique muscle to Poupart's ligament.*—The cord is held aside by gauze or suitable retractors, approximate the conjoined tendon and internal oblique muscle with the deep aspect of Poupart's ligament by interrupted sutures. All the sutures lie at the inner side of the internal ring except one which lies on the outer side of this ring. Thus a floor is formed; release the cord and let it rest on this floor (Fig. 76).

6. *Suture of the external oblique.*—The cut margins of the tendon of the external oblique muscle are brought together by a continuous or a series of interrupted sutures; while doing this, the external abdominal ring is narrowed just short of causing any constriction of the cord as it passes through it (Figs. 77 and 78).

7. *Closure of the wound.*—The skin wound is closed by silkwormgut sutures leaving a small opening for drainage if it is considered necessary. If Mitchell's clips are used for suturing, no drainage will be necessary.

Comment.—(1) In making the superficial skin incision confine it as much as possible to the abdominal wall avoiding the scrotum. (2) Before transfixing the sac make it absolutely certain by inspection and exploration with the finger that hernial contents are not transfixed with the sac. (3) In returning the stump, see that it is free of any attachments with the internal ring or its neighbourhood. (4) In operating on a dead subject who had no hernia, no sac will be found. (5) As a modification of Bassini's operation the cord may be left behind the internal oblique.

II. Halstead's method.—

The first five stages of this operation correspond with Bassini's method. Halstead modifies the sixth stage by

PLATE XXV.
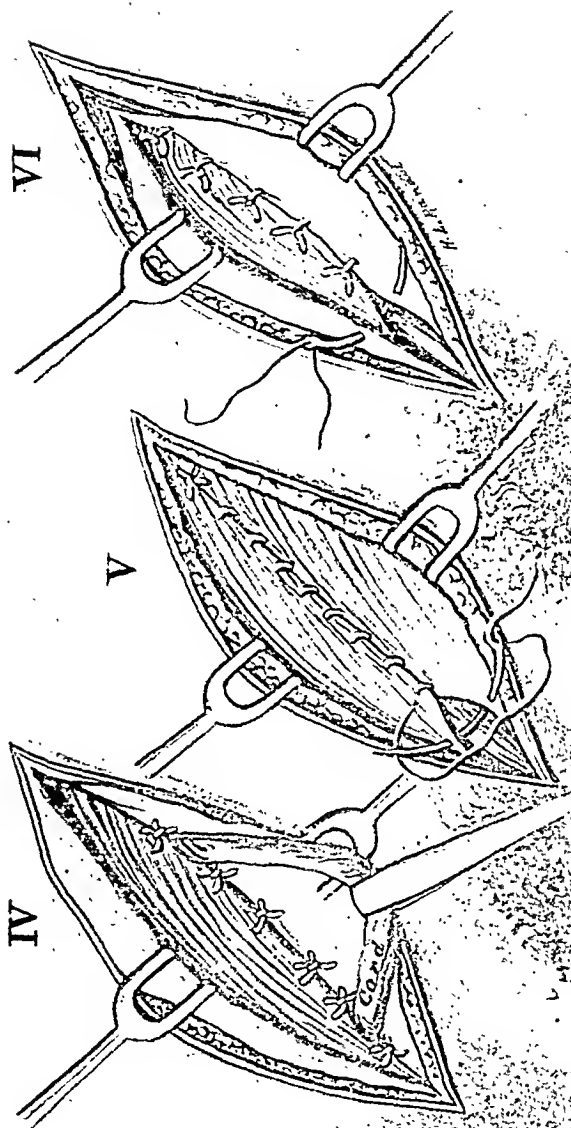
FIG. 76.   FIG. 77.   FIG. 78.

Bassini's operation for hernia.

suturing the external oblique with an overlap. The edge of
the lower flap is attached to the deep surface of the upper
one and the upper flap is brought down and sutured to the
surface of the lower flap. Thus there is a double layer
strengthening the inguinal canal. The wound is closed in
the usual way.

III. Author's modification of Bassini-Halstead method.--

After completing Bassini's fifth stage I overlap the external
oblique Halstead fashion, but while doing so I plicate fibres of
the external oblique, taking in here and there, a few fibres of
the internal oblique and transversalis. This strengthens the
anterior wall and at the same time does not split the fibres
of external oblique as is sometimes seen in Halstead's opera-
tion (Figs. 79 and 80).

IV. Kocher's method. --

Kocher treats the sac in the following way :—The hernial
sac is invaginated or turned inside out before it is excised.
The lowermost part of the fundus of the sac is seized with a
pair of Kocher forceps and is pushed into the sac itself thus
invaginating it into peritoneal cavity. The external oblique
is not divided as in Bassini's and other operations. The tip
of the forceps is pushed to a point above and to the outer
side of the internal abdominal ring, and it is made to bulge
into the anterior abdominal wall. A small incision is made
cutting through all the tissues excepting parietal peritoneum
on the bulging point. As the sac covered by parietal
peritoneum and held by forceps protrudes through the
small incision in the parietal peritoneum, it is immediately
caught by two clip forceps. A small nick is made in the
parietal peritoneum. The invaginated sac is pulled through it,
and the Kocher forceps removed from the inguinal canal.
The sac is then transfixed by its neck to the parietal
peritoneum.

VII

Ext. Obl.

Fig. 80.

VIII

Ext. Obl.

Fig. 79.
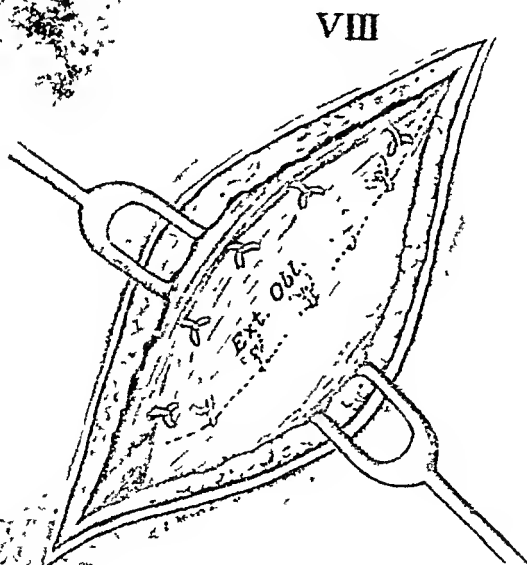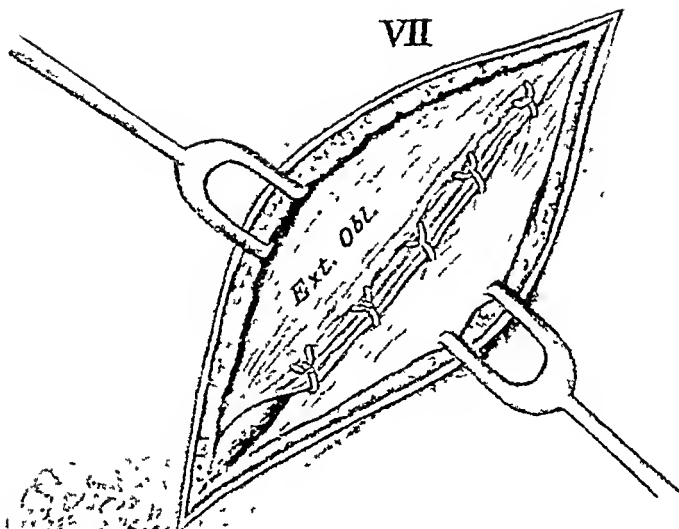
Bassini Operation for Hernia.
(Author's modification)

V. Macewen's method.—

Macewen treats the sac by transfixing it with a curved needle several times from its fundus upwards so that on drawing the suture the sac becomes puckered up. The ends of the suture are then threaded on to a hernia-needle and guided into the canal by finger and it is made to transfix the muscular wall of the abdomen from within outwards, about one inch above and to the outer side of the internal abdominal ring. It is secured there and fixed to the aponeurosis of the external oblique so that the sac (thus puckered up) lies like a button in this situation.

FEMORAL HERNIA.

Surgical Anatomy.—The femoral sheath consists of three compartments. In the outermost compartment is the femoral artery ; in the middle the femoral vein and the innermost compartment consists of the crural canal. The upper end of the crural canal, *i.e.*, the crural ring is closed by the septum crurale which is formed by a thin process of fascia transversalis and a lymph gland with some areolar tissue. The crural canal is bounded by the femoral vein externally, Poupart's ligament above, Gimbernat's ligament internally, and pectineal fascia covering the pectineus muscle lying on the horizontal ramus of the os pubis behind. In femoral hernia the sac protrudes through the septum crurale pushing in front of it the lymph gland and areolar tissue. The sac with its contents descends along the crural canal forcing its way downwards under Poupart's ligament through the cribriform fascia of the saphenous opening. The deep epigastric artery lies above and to the outer side of the femoral hernia and its branch an abnormal obturator artery may lie in front of it or to its inner side.

Indications.—(1) All femoral herniæ should be radically treated by operation, because they may at any moment become irreducible, inflamed or strangulated ; also because the femoral hernia is difficult to control by applying a truss. (2) All irreducible femoral herniæ. (3) Femoral herniæ

threatening to become strangulated or already strangulated.
(4) Femoral herniæ which incapacitates the sufferer from
following his ordinary vocations. (5) In order to obtain
physical fitness to enter public service. (6) In women in
whom femoral herniæ tends to become strangulated during
parturition.

Instruments—Group XVII.

Operation.—Femoral herniotomy consists in exposure,
isolation and excision of the sac and effective closure of the
femoral ring. Various methods have been adopted to attain
these ends, but Kocher's method which is as good as any of
the others will be described.

Kocher's operation for femoral hernia.—

Skin incision.—Make an incision parallel to and a little
above the inner half of Poupart's ligament. This divides the
superficial fascia and exposes the sac.

Exposure and isolation of the sac.—Isolate the sac by
freeing it from surrounding adhesions from within and above.
Transfix it by double ligature or a Staffordshire knot leaving
long ends to the ligature and remove the fundus beyond
the ligature.

Fixation of the sac.—Make a small opening by splitting
through the abdominal parietes a little to the outer side of
the external abdominal ring. Introduce a blunt needle
through this opening towards the stump of the sac and draw
it forward by means of the long ends of the ligature threaded
to the eye of the needle.

Closure of the femoral ring.—Pass one, two or more
sutures through the pectineal fascia and Cooper's ligament
behind and Poupart's ligament in front.

Bassini's operation.—

This operation resembles Kocher's operation in many
respects. The sac is ligatured and the fundus cut away. The
stump is allowed to slip back. He closes the femoral ring

C, OS   13

by two sets of sutures. The second set which lies on a superficial plane connects the falciform edge of the saphenous opening with the pectineal fascia.

Comment.—(1) Kocher sometimes invaginates the sac, brings it through the opening in the abdominal parietes, ligatures and fixes it and then removes the fundus.   (2) Complete isolation and detachment of the sac at the femoral ring is an important step of the operation as it ensures an efficient closure of the femoral aperture.   (3) The different anatomical structure which is brought into requisition for the closure of the femoral ring should be clearly identified ; these are the pectineal fascia, the pectineus muscle and the pubic bone behind, the lower aspect of Poupart's ligament in front ; Gimbernat's and Cooper's ligaments, the falciform process and the saphenous opening.

CHAPTER XX.

OPERATIONS ON THE RECTUM AND ANUS.

Surgical Anatomy.—The rectum which is the lowermost part of the bowel consists of two segments, the upper, *i.e.*, the rectum proper is five inches long, commences from the termination of the pelvic colon in front of the body of the third sacral vertebra and terminates in the anal canal below, at a point one inch beyond the coccyx. The lower segment consists of the anal canal, one-and-half inches long, extending from the termination of rectum proper to the margin of the true skin. The rectum proper or ampula has a thick vascular mucous membrane which is arranged in horizontal folds in its upper part, two or three of which are more prominent and are called Houston's valves. The muco-cutaneous junction in the anal canal is marked by a white line which is called Hilton's white line. From this, thickened processes of mucous membrane pass vertically upwards and are known as columns of Morgagni. Between these· columns are a series of short semilunar valves with small crypts—the valves and crypts of Morgagni. The external sphincter is composed of voluntary striped muscles and surrounds the anal canal. The internal sphincter is composed of a thick portion of the circular fibres of the middle coat of the bowel and encircles the upper part of the anal canal; it terminates about the level of Hilton's white line. The rectum is supplied by the superior hæmorrhoidal, the middle hæmorrhoidal, the inferior hæmorrhoidal and the middle sacral arteries. It is thus supplied both by portal and systemic arteries. The veins commencing in the hæmorrhoidal plexus carries blood by the superior hæmorrhoidal vein through the inferior mesenteric into the portal circulation.

The middle and inferior hæmorrhoidals and the middle sacral vein, carry blood through the systemic circulation to the inferior vena cava.

Hæmorrhoids or Piles.

Varieties.—Three varieties are recognised. (1) Internal piles are those which implicate the terminal branches of superior hæmorrhoidal vessels and are covered by mucous membrane ; they originate in the lowermost part of rectum and the anal canal. (2) External piles are those which implicate the branches of the inferior hæmorrhoidals and are seen in the part of anal canal that is lined by skin. (3) Mixed piles are those in which both the varieties co-exist.

Indications.—(1) Continual loss of blood. (2) Persistent tendency for the piles to protrude. (3) Lowering of the patient's general health due to loss of blood and constant irritation and pain.

Position.—Lithotomy position. Surgeon sits facing the patient's perineum and the assistant stands on his left.

Instruments.—Group XVIII.

Operations.—Various methods of removing piles have been practiced but the following will be described :—

1. Ligature and excision.
2 Excision and suture (Mitchell's operation).
3. Author's modification of Mitchell's operation.
4. Excision of the pile-bearing area (Whitehead's operation).
5. Clamp and cautery.

1. Ligature and excision.—This is suitable for pedunculated piles. Introduce two thumbs within the bowel and dilate the sphincter steadily and slowly first in the transverse and then in the antero-posterior direction. This brings the piles into view and enable them to be caught and drawn down beyond the anal orifice. The individual piles are defined, seized with forceps and its neck grasped by crushing forceps ; a catgut ligature is applied securely on the groove thus formed.

The portion of the pile beyond forceps is cut away with scissors. In some piles with broad pedicles, the · base is transfixed and secured in two halves by Staffordshire knot.

2. Excision and suture.—(Mitchell's operation.) Mitchell of Belfast describes an operation which is very widely practised now. The anus is dilated and the base of each pile is clamped in the long axis of the bowel with a pair of narrow bladed hæmostatic forceps. The redundant portion of the pile is removed. A catgut suture is applied at the tip of the forceps, secured with a knot and is carried as a continuous suture including the forceps and the tissues around the base of the pile. Now the forceps is removed and the suture tightened almost simultaneously. The remaining piles are treated in a similar way. These sutures not only arrest hæmorrhage but close the wound without leaving a raw surface.

3. Author's modification of Mitchell's operation.— I adopt Mitchell's method modifying the sutures as follows : I introduce a catgut suture at the tip of Kocher's forceps, but instead of tying a knot here at the commencement, I leave a long end of the catgut and then carry the suture as in Mitchell's operation, leaving another long end at its termination. (Fig. 81). After withdrawing the needle I pick up these ends of the suture with the left hand, and pull it out as I release the blades of the forceps and slip it through. I immediately tighten the suture further and finish off with a knot securely tied. This operation seems to have some advantages : (*i*) Hæmostasis is more perfect, (*ii*) accessory sutures or ligatures are not required, (*iii*) the apposed raw surface is brought together as if after a purse-string suture, (*iv*) the operation can be done more quickly and (*v*) the wound heals rapidly.

4. Excision of the pile-bearing area.—(Whitehead's operation.) The piles are made to protrude as in the previous operation. Carry an incision round the circumference of the anus separating the mucous membrane from the skin. Catch

the mucous membrane with forceps and peel it down by a blunt dissector from the submucous tissue for the whole extent of pile-bearing area. On reaching the upper limit of the piles, cut transversely across the healthy mucous membrane and bring this down to the line of former incision at the anal margin. The cut margins are brought together by interrupted catgut sutures.

5. Clamp and cautery method.—The piles are brought down, the pedicles crushed with clamps and the projected portion, burned off with cautery at a dull red heat. This operation is seldom performed now.

Ano-rectal fistulæ—Fistula-in-ano.—These are abnormal tracks or sinuses being the remains of unobliterated abscess cavities which have not healed. They may open in the skin, into the rectum or in both directions. A complete fistula has two or more external openings within an inch and a half of the anus and generally one internal opening situated in the rectum between external and internal sphincters of the anus.

Incomplete fistulæ are of two varieties. The blind external fistula has an external opening only on the skin. The blind internal fistulæ have an internal opening in the anorectal canal.

Position.—Same as for operation of piles.

Instruments.—Group XVIII.

Operation.—For a complete fistula, introduce a probe-pointed director from the external to the internal opening and feel for its tip by a finger introduced into rectum. The whole track is laid open by cutting down on the director through the skin and mucous membrane. The probe is withdrawn and cut edges retracted by means of tissue-forceps. The unhealthy granulation and fibrous tissue lining the fistulous track is removed by scraping and dissection. The edges of the skin if unhealthy, are snipped off with a pair of scissors. The clean raw surfaces are apposed by means of interrupted catgut sutures. An incomplete fistula should be rendered

PLATE XXVII.
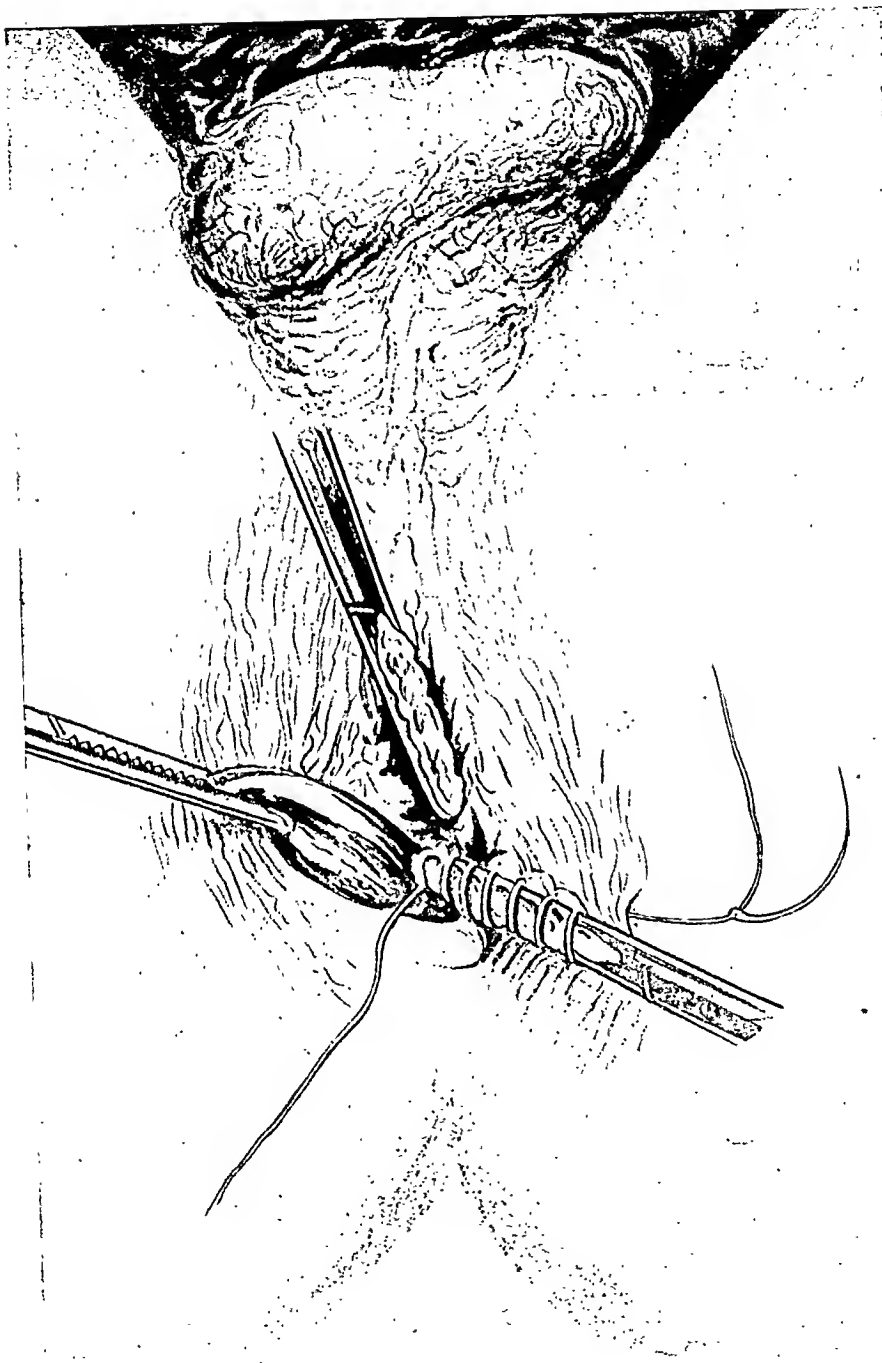
FIG. 81.
Author's modification of Mitchell's operation.

complete by introducing a probe or director through the existing opening along the track and then cutting down on its tip as it is made to bulge through the soft tissues. The rest of the operation is performed as for complete fistulæ.

Comment.—(1) For very septic fistulæ no attempt should be made to suture the edges. (2) The sphincter should not be divided unnecessarily. (3) If the division is unavoidable it should be divided by cutting across the fibres at right angles to them but not obliquely. (4) The fibres should not be divided at more than one point, otherwise the patient may suffer from incontinence of fæces.

CHAPTER XXI.

PARACENTESIS.

Paracentesis for pleural effusion.

Indications.—

1. *For serous effusions.*—(1) Cases in which the effusion shows no signs of abatement, but increases in spite of medicinal and other treatments. (2) Cases in which it causes respiratory distress, *e.g.*, dyspnœa, orthopnæa, etc. (3) Cases which cause cardiac distress with displacement of heart. (4) Cases in which it causes pressure such as on the oppositive lung.

2. *For purulent effusions.*—Ordinarily empyema should be treated by drainage after excision of one or more ribs, with the exception of the following conditions : (*a*) bilateral empyema, (*b*) localised empyema, (*c*) in tubercular localised empyema, (*d*) in the very young and in the very old.

Instruments.—Group XII.

Position.—The patient lies on his sound side if possible, otherwise he is placed in a recumbent position.

Operation.—Select an interspace which according to the extent of the effusion would be most suitable. The sixth space in the posterior axillary line is most frequently selected, the seventh, eighth and ninth space may be selected in the scapular line. Make a small puncture with the point of a scalpel. Thrust the aspirating trocar and canula in for a sufficient distance guided by the upper border of the two ribs, so that it reaches the fluid, but does not injure the lung. Now, withdraw the trocar and draw the fluid slowly. After the necessary quantity of fluid has been withdrawn by successive but incomplete exhaustion of the aspirating bottle, introduce the blunt stillet into the canula and withdraw it. While doing so, pinch up the skin at the site of puncture. The puncture can be sealed with collodion or closed by a silkwormgut stitch.

Comment.—(1) It is preferable not to use general anæsthesia, local infiltration anæsthesia being more suitable. (2) Provision should be made against sudden attack of syncope and fainting. (3) The flow should be stopped when the patient gets an irritating cough, if he faints or if the fluid becomes bloody.

Paracentesis for peritoneal effusion.

Indications.—Ascitic fluid has to be withdrawn by tapping or aspiration when the distention becomes a source of respiratory and cardiac distress to the patient and the pressure on the abdominal and thoracic organs dislocates their physiological functions.

Position.—Patient is seated on the bed supported on back rest or seated on a chair with adjustable back.

Instruments.—Group XII.

Operation.—A point is selected in the linea alba halfway between the symphisis pubis and the umbilicus. A binder is applied round the abdomen, so that the greater part of it lies above point of puncture and the rest below it. It is so arranged that the binder can continuously be tightened by two assistants holding its ends. Make a puncture at the previously ascertained point with a tenotome or a fine scalpel and insert the trocar and canula. Withdraw the trocar and let as much fluid escape as is desirable. The assistant keeps tightening the binder during the process. Introduce the trocar halfway into the canula and withdraw it. Close the puncture as in the previous operation.

Comment.—(1) The bowels should be thoroughly evacuated previously and the bladder emptied before operation. (2) It is not desirable to withdraw the whole ascitic fluid. (3) It is undesirable to remove fluid due to malignant diseases of the internal organs. (4) If the patient faints, stop the flow of the fluid until he recovers. (6) Tapping for recurrent ascites is not recommended for more than two or three occasions. (6) Paracentesis for ascites in children should be avoided whenever possible.

CHAPTER XXII.

OPERATIONS ON THE GENITO-URINARY TRACT.

UNDER this heading will be considered the following :—
Operations on the kidneys.
Operations on the bladder.
Operations on the urethra.
Operations on the penis.

THE KIDNEYS.

Surgical Anatomy.—The kidneys are $4\frac{1}{2}''$ long, $2\frac{1}{2}''$ broad and $1\frac{1}{2}''$ thick. Viewed anteriorly, the kidneys are obliquely placed in such a manner that the upper poles lie from $1\frac{1}{2}''$ to $2''$ from the middle line ; and the lower poles $2\frac{1}{2}''$ to $3'''$ from the same line. The upper pole of the right kidney is on a level with the body of the twelfth thoracic vertebra ; the upper pole of the left is on a level of the intervertebral disc between the eleventh and twelfth thoracic vertebræ. The right kidney therefore is on a slightly lower level than the left. They are placed behind the peritoneum. Each kidney, besides its own capsule has a fatty capsule. The pleuræ, though in close proximity to the upper poles of the kidneys are not directly related to them. The posterior relations of the kidneys are important as they are generally exposed from behind through a lumbar incision.

Operation for exposure of the kidney.

The kidneys can be exposed by an *anterior trans-peritoneal route* or by *posterior lumbar route.* The *lumbar route* is chosen

in a large majority of cases for the following reasons :—(1) it allows sufficient room to perform almost all the necessary operations with ease ; (2) statistics show that it is much safer than the trans peritoneal route ; (3) in a large proportion of cases operations on the kidneys are undertaken for its septic conditions and as such, the trans-peritoneal route should be avoided. The *trans-peritoneal route* is recommended only for one or two exceptional conditions, namely, if a kidney tumour is so unusually large that it cannot be delivered through a lumbar opening or when there are many perinephric adhesions.

Exposure of the kidney by the lumbar route.

Instruments.—Group XX.

Position.—The patient lies on the opposite side with a sandbag introduced into the ilio-costal space of that side. This gives the maximum of space between the last rib and iliac crest on the side to be operated. The operator can stand on either side but preferably behind the patient and the assistant stands opposite to him.

Operation.—Recognise the boundaries of the ilio-costal space by the following three landmarks :—(*a*) the outer border of the erector spinæ muscle which is about a hand's breadth from the middle line, as the inner boundary, (*b*) the crest of the ilium below and (*c*) the twelfth rib as the boundary above.

The operation can be described in three stages :—

(*i*). *Incision.*—Commence an incision at the junction of the twelfth rib with the erector spinæ muscle and carry it obliquely downwards and forwards to the anterior superior iliac spine. The length of the incision is on an average $3\frac{1}{2}$ inches, but it has to be longer in a fat subject. This divides the skin and superficial fascia and exposes the latissimus dorsi above and the external oblique below. Divide these muscles. Divide the internal oblique and transversalis muscles which are now exposed. The lumbar aponeurosis which is now exposed is divided. Clear the upper angle of the incision. The quadratus lumborum muscle with its vertical fibres is now

exposed. Anterior to the edge of this muscle is some loose fat covering the peritoneum. Clear the fatty tissue posterior. to it, the peri-renal fascia is thus exposed and divided. Feel for the kidney through the peri-renal fat. Divide the peri-renal fascia in its posterior aspect in the whole length of the incision. The lower pole of the kidney can be seen.

(*ii*). *Delivery of the kidney.*—Catch with forceps the retro-renal fascia in front of the opening. Separate the fatty tissue surrounding the kidney, clear its upper and lower poles.

(*iii*). *Exploration of the kidney.*—Compress the pedicle between the forefinger and thumb of the left hand. At this stage the following explorations can be made ; (*a*) examination of the exterior of the kidney and pelvis ; (*b*) examination of the exterior of the ureter ; and (*c*) exploration of the interior of the pelvis and kidney by an incision in the pelvis (pylotomy) or through an incision in the kidney (nephrotomy).

Comment.—(1) In defining the ilio-costal space make sure of the twelfth rib as its upper boundary. It is a good custom to count the ribs from above. If the eleventh rib is mistaken for the twelfth the pleura may be opened into. (2) In dividing the skin and muscles avoid cutting the last dorsal nerve above and the ilio-hypogastric nerve below the muscle section.

THE BLADDER.

Operations on the bladder.

Surgical Anatomy.—The bladder occupies the anterior part of the pelvic cavity lying behind the symphysis pubis. The empty bladder lies entirely within the pelvis. When dilated, its highest point lies above the symphysis, and then there is an area on its anterior surface from one to two inches above the pubis uncovered by peritoneum. It is on this area that the bladder can be punctured or opened without entering the peritoneal cavity. *Space of Retzius* is the area anterior to the bladder limited in front by the pubis, above by the peritoneal reflection, behind by the bladder ; laterally, it is

continuous with the space occupied by the extra peritoneal fat, and below with the cellular tissue of the pelvis. This space contains loose areolar tissue and lobules of fat. Extravasation of urine due to extra-peritoneal rupture of the anterior wall of the bladder extends into this space.

Suprapubic cystotomy.

This operation means opening into the bladder through the suprapubic region.

Indications.—

(1) Vesical growth.

(2) Enlargement of the prostate.

(3) Some cases of cystitis which require drainage.

(4) Vesical calculus (suprapubic lithotomy).

Instruments.—Group XXI.

Position.—The patient lies on his back in the semi-Trendelenburg position. Operator stands on the right side and the assistant opposite to him.

Operation.—This is described in five stages :—

1. *Distension of the bladder.—*Distend the bladder by injecting about eight to ten ounces of fluid into it or with air, so that the upper limit of the bladder rises about half way between the upper margin of the symphysis and the umbilicus.

2. *Exposure of the bladder.—*Make a skin incision about three inches long precisely in the middle line, the lower limit of the incision being over the middle of the symphysis pubis. Deepen the incision by separating the recti and pyramidalis of either side in the middle line and retract them. The transversalis fascia which is attached to the posterior aspect of the symphysis is exposed. Divide it in the middle line carefully. The vesico-pubic reflection of the peritoneum is exposed. Retract it upwards. The bladder is now exposed. It is recognised by the fluctuating resistance it gives to the palpating finger, the irregular arrangement of the fibres of its muscular coat and the vesical veins which run on the surface.

3. *Opening of the bladder.*—Protect the peritoneum at the upper angle with gauze and a retractor. Pick up the bladder wall by its muscular coats with two pairs of forceps applied on either side of the middle line. Open it by an incision through its walls from a point below the peritoneal reflection down towards the symphysis, avoiding the veins. Secure the cut edges of the bladder with catgut or silk passing only through its muscular coat. Intravesical procedures can be taken up now according to necessities of the case. (*Vide infra*).

4. *Treatment of the bladder wound.*—At the upper end of the wound is the vesico-pubic reflection of the peritoneum. This aspect is shut off by suture carried through the muscular wall of the bladder, the transversalis fascia, and the muscles of the abdominal parietes. The lateral aspects towards the opening at the subperitoneal fat is similarly shut off. At the lower angle of the wound the lower part of the space of Retzius is also shut-off in a like manner. The bladder wound may either be closed or left open for drainage. These should be carried out as follows :—

(i) Closure of the bladder wound.—This is done by layers of sutures through the muscular and the submucous layer of the bladder wall, none of them penetrating the mucous layer.

(ii) Suprapubic drainage.—The bladder wall is sutured in a manner similar to the above leaving just enough space for the introduction of a drainage-tube.

5. *Closure of the abdominal wound.*—The abdominal wound should be closed entirely in the usual way if the bladder has been sutured, the recti and the pyramidales being allowed to meet in the middle line. A small drain may be left through the most dependent part. If the bladder is to be drained, the abdominal wound is partially closed.

Comment.

1. Protect the vesico-pubic reflection of the peritoneum throughout the operation.

2. In opening the bladder do not extend the incision too high up towards the peritoneal reflection or too low down into the space of Retzius.

3. In suturing the bladder, take great care not to enter into the mucous surface; deposits may take place on the ligature material to form a nucleus for a future calculus.

Suprapubic Lithotomy.

This is an operation for removal of stone from the bladder after performing suprapubic cystotomy.

ndications.—(*a*) In cases of hard stones; (*b*) for stones of more than an inch and a half in their shortest diameter; (*c*) for stones of soft consistency which may stick to the jaws of the lithotrite, *e.g.*, in cases of calculi which have been formed round a soft foreign substance; (*d*) in cases of encysted stones; (*e*) in cases where the bladder is sacculated; (*f*) in cases where there is obstruction in the urethra or the neck of the bladder through which the lithotrite cannot be passed, *e.g.*, stricture of the urethra and enlarged prostate; and (*g*) in cases where due to cystitis, the bladder has to be drained after removal of the calculus.

Instruments.—Group XXI.

Position.—Same as suprapubic cystotomy.

Operation.—The operation can be described in five stages, the first four of which correspond to those for suprapubic cystotomy.

In the fifth stage, the bladder is anchored by tissue-forceps or by retaining sutures. Now, an assistant introduces his finger into the rectum and pushes the stone anteriorly; or the rectum may be dilated by means of a pneumatic bag. The left forefinger is introduced into the bladder and the stone felt for. It can now be delivered with two fingers or a finger and a lithotomy scoop; or it may be caught in the blades of lithotomy forceps guided by the finger and then removed. A soft rubber catheter should be introduced into bladder through the urethra, the bladder irrigated and all blood clots

washed out. The wounds in the bladder or abdominal wall can be closed or kept open as circumstances indicate.

Comment.—

(1) The wounds of the bladder and the abdominal wall should be closed whenever possible as the constant soakage of the dressings and the irritation caused by it is very troublesome to the patient.

(2) The incision in the bladder should be made in corresponding to with the size of the stone.

(3) Any attempt at delivery a large stone through a small opening in the bladder forcibly will lacerate the edges of the wound ; this must be avoided.

(4) The catheter should be left *in situ*.

(5) Encysted stones in the bladder should be removed by gently peeling the mucous membrane and the stone extracted by working bi-manually with the operator's finger in the bladder and the assistant's finger in the rectum.

Litholapaxy.—

A lithotrite is introduced into the bladder, the stone crushed and evacuated.

Indications.—(1) A medium sized stone, not too hard for the lithotrite to crush it, (2) nor too soft which would stick to the blades of lithotrite ; (3) the urethra admits and tolerates the passage of the lithotrite ; (4) the prostate is not enlarged ; (5) the bladder is not irritable or septic nor congested or contracted due to hypertrophy or otherwise ; and (6) the patient is in a condition to undergo prolonged anæsthesia.

Position.—Dorsal position.

Instruments.—Group XXII.

Operations.—The bladder is first emptied of urine and then distended by injecting four to eight ounces of saline solution or boric lotion. The lithotrite is locked and introduced, the stone crushed and the instrument is withdrawn after locking. The evacuating canula is then introduced, the

evacuator adjusted to it and worked till the fragments are sucked into it. This process is repeated two, three or more occasions till it is ascertained that no more stones or fragments are left. The cystoscope is then introduced and the interior of bladder inspected to see if any fragments are left. The bladder is then washed out. This completes the operation.

Comment.—Different sizes of lithotrites should be selected and prepared. Different sizes of canulæ and two evacuators should be kept ready. It is difficult to anæsthetise a patient with irritable bladder for this operation.

Removal of stones by the lateral or median perineal lithotomy is seldom if ever undertaken now-a-days.

Prostatectomy.

Surgical Anatomy.—The prostate gland surrounds the portion of urethra at its commencement which is called the prostatic urethra. Above, it is in intimate connection with the bladder, while anteriorly, posteriorly and laterally it is in relation with pelvic connective tissue and fascial layers. Its apex is in relation with the deep layers of the triangular ligament. On the lateral aspects are the vesico-prostatic plexus of veins. It has a capsule, the prostatic capsule, derived from the pelvic fascia and it is within this fascia that the prostatic plexus of veins lie. The true capsule of the prostate is a strong fibro-muscular capsule and extends over the entire gland excepting the anterior and posterior commissures. This is so intimately connected with the glandular mass that it is incapable of separation from it.

Instruments.—Group XXIII.

Operation.—The prostate can be removed in different ways :—

(1) Perineal prostatectomy (Young).
(2) Combined perineal and suprapubic prostatectomy.
(3) Partial prostatectomy (MacGill).
(4) Freyer's suprapubic prostatectomy.

The last named operation will be described.

Suprapubic prostatectomy.—Total enucleation of the prostate (Freyer).

Indications.—(1) Enlargement of the prostate giving rise to overdistention of the bladder, overflow incontinence and frequency of micturition ; (2) recurring retention of urine ; (3) increasing quantity of residual urine ; (4) cases in which "catheter life" has given rise to cystitis, hæmorrhage and other complications ; and (5) enlarged prostate with vesical calculi.

Position.—The patient lies on his back in the semi-Trendelenburg position with thighs separated and secured. Operator stands on the left side of the patient and assistant opposite to him.

Instruments.—Group XXIII.

Operation.—Wash out the bladder and then fill it with warm boric lotion with a soft rubber catheter. Leave catheter *in situ.*

The operation can now be described in four stages :—

1. *Suprapubic cystotomy*—is performed as has been described.

2. *The enucleation.*—Introduce the left index finger into the rectum and push the prostate upwards towards the cavity of the bladder. Introduce the right index and middle fingers into the bladder through the suprapubic wound and tear through the mucous membrane of the bladder over the prostate round the urethral opening with the finger and the finger nails. Seek for the intercapsular plane, *i.e.*, the plane between the true and false capsules. Once in this plane, sweep the finger round the gland, tearing through the prostatic urethra in the process. The gland will thus be loose in the bladder cavity and can be removed. The index fingers of both hands will be in active co-operation during the whole process.

3. *Toilet of the wound*—and drainage of the bladder. Squeeze and massage the capsule of the prostate left behind with two forefingers. Wash out the bladder with hot sterile

tube and close the bladder wound round by catgut suture. The bladder drains both by suprapubic drain and the catheter which has been left *in situ*. I had satisfactory results by continuous irrigation of the bladder through the catheter and the tube.

4. *Closure of the abdominal wound.*—Introduce a drain in the space of Retzius and close the parietal wound partially by interrupted sutures first taking in the recti on either side and then other muscles, leaving enough space for the drainage tube.

CHAPTER XXIII.

OPERATIONS ON THE GENITO-URINARY TRACT. (*Contd*).

THE URETHRA.

Surgical Anatomy.—The length of the urethra averages about eight inches. It is divided into two parts ; from the meatus to the opening of the triangular ligament, measuring about six inches is called the anterior urethra. The remaining portion of it is called the posterior or deep urethra.

The anterior urethra is again sub-divided into four parts, navicular, penile, scrotal and bulbous. (*i*) *The navicular* portion corresponds to the glans penis. It extends from the meatus which is the narrowest part of the whole urethra, then it widens out and contracts again at its junction with the penile portion. (*ii*) *The penile*, the most mobile portion, varies in .length and can be easily palpated. (*iii*) *The scrotal* portion is deeper and more fixed and can be palpated through the scrotum. (*iv*) *The bulbous portion* half an inch in length, is fixed to the anterior surface of the triangular ligament. It is wide and distensible. It cannot be palpated normally ; it can, however, be palpated when a bougie has been passed into it or when the walls are indurated. It is the most dependant part of the urethra and is the commonest seat of stricture, gonorrhœal or traumatic. The opening in the triangular ligament represents the junction of anterior and posterior parts of the urethra. This is the most fixed and next to the meatus, the narrowest part of the urethra. False passages are commonly made here.

The posterior or deep urethra consists of two portions, the membranous and the prostatic. (*i*) *The membranous portion* half an inch long in its anterior wall and three-fourth inches long in its posterior wall, is situated about one inch below the lower border of the symphysis pubis. It is surrounded by the compressor urethræ muscle. An instrument in this portion of the urethra can be felt by the finger introduced into the rectum, just anterior to the prostate. (*ii*) *The prostatic urethra* an inch and a quarter long, is the widest and most distensible portion of the whole canal. It can be palpated per rectum through the prostate.

Operations on the urethra.

1. Meatotomy, *i.e.*, cutting into the meatus in cases of its narrowing (either congenital or post-inflammatory) or preliminary to the introduction of the urethral bougies or sounds. Pass a probe-pointed knife for about three-fourths of an inch to a point immediately behind the meatal narrowing and cut with a sawing movement in the middle line below. Keep the wound open by passing a sound and applying a little sterile vaseline.

2. Operations for stricture of the urethra.—These include :—

    (A) Internal urethrotomy.

    (B) Urethrectomy (excision of the stricture).

    (C) External urethrotomy.

    (D) Dilatation by bougies.

    (A) Internal urethrotomy, *i.e.*, division of the stricture from inside the urethra by introduction of an urethrotome into the canal.

Indications.—

    (1) For strictures which are localised and annular.

    (2) For strictures situated in the urethra from the meatus up to the bulbo-membranous junction.

(3) When the stricture is resilient or valvular and repeated dilatations have failed.

(4) When the urethra is so sensitive that the patient can not bear dilatation.

It is contra-indicated in : (1) strictures which are not localised ; (2) when there is peri-urethral inflammation and septic complications ; and (3) when it is feared from previous experiences with individuals that there may be hæmorrhage.

There are two methods of this operation —(1) in which the stricture is divided from before backwards and (2) in which it is divided from behind forwards. After the division of the stricture, a full sized bougie should be passed from time to time to prevent the part from cicatrising again.

B. Urethrectomy.—This is an operation in which a part or whole of the circumference of the urethra is removed. It is best to preserve a portion of the urethra to help apposition. The site of the stricture is at first ascertained. An opening is made through the skin into that part ; if it is excised from the penile portion, it is penile urethrectomy, and if from a lower portion, through the perineum it is perineal urethrectomy. A sound is passed as a guide, the urethra is opened ; the strictured portion is removed and the ends brought into apposition by catgut sutures. Even after healing it leaves a scar and a sound has to be passed from time to time to keep it dilated.

C. External urethrotomy.

Indications.—

(1) For impermeable strictures.

(2) For strictures in which internal urethrotomy is inapplicable.

(3) For traumatic strictures in which cicatrisation is extensive.

(4) In strictures complicated with peri-urethral abscesses, fistulæ and false passages.

(5) In extravasation of urine with peri-urethral cellulitis.

(6) In cases of stricture with cystitis.

Position.—Lithotomy position. Operator sits facing the perineum and the chief assistant stands on the left side facing him and in charge of the staff ; another assistant stands on the operator's left to help in retracting parts. There are two methods of external urethrotomy.

I. External urethrotomy with a guide (Syme's operation).

In this operation the stricture allows the passage of some instrument such as a Syme's staff, a filiform bougie or a median grooved lithotomy staff as a guide for the further stages of operation. Ascertain the site of the stricture. Cut down upon it, and while doing so, incise a contiguous portion of healthy urethra ; introduce a probe-pointed director into the bladder, guided by the groove of the staff. Now withdraw the staff. The urethra is now dilated ; retract its cut edges. Then pass a Teale's gorget through this opening into the bladder guided by the director. Introduce a full sized catheter or a perineal drainage tube to complete the operation.

2. External urethrotomy without a guide (Wheelhouse's operation).

This operation is indicated for strictures through which no instrument could be passed. Pass a straight grooved staff of Wheelhouse pattern down to the face of the stricture. The assistant steadies it precisely in the middle line with the grooved side towards the operator. Cut down on the groove, distal to the stricture into the urethra ; the assistant now turns the staff round and retracts the upper end of the cut with the hooked end of the staff. Retract the cut edges of the stricture on either side. Look for the stricture, cut into it in the middle line till at the proximal end of the

stricture healthy urethra is seen. The probe-pointed director is introduced through this opening in the stricture, into the bladder and the operation completed as in the previous one.

: **D. Dilatation by bougies.**—An uncomplicated stricture can be dilated by passing a series of these instruments at regular intervals.

Position.—Dorsal position. Operator stands on the left side facing the patient and assistant stands opposite.

Operation.—Hold the bougie lightly with the right hand parallel to Poupart's ligament. Grasp the penis with the left hand and introduce the tip of the bougie through the meatus into the navicular portion ; introduce it as far as it would easily go, keeping it in contact with the floor of the urethra in order to prevent it from being caught in the lacunæ situated on the roof of this portion. Now, bring the bougie round to the middle line of the body, making an arc of a circle with the hand. Now pass the tip through the bulbous portion. A slight obstruction will be felt at the junction of the bulbous and membranous portions. Bring the hand down between the thighs of the patient depressing the handle to keep the tip in contact with the roof of the membranous portion. This will avoid a false passage being caused by perforation of the floor. Now, pass the tip through the membranous portion. The sound is now passing between the two layers of the triangular ligament and surrounding it is the compressor urethræ muscle. With a slight coaxing, the tip will pass through these into the dilated prostatic portion and then into the bladder.

Comment.—Obstructions may be felt at the following situations :—

(i) At the meatus ; if it is too narrow it has to be slit (*meatotomy*). (ii) At the lacunæ of the navicular portion ; avoid this by keeping the tip on the floor. (iii) At the bulbous portion if there is a stricture. (iv) At the junction of the membranous and bulbous portions ; keep the tip in

contact with the roof. (*v*) In the membranous portion due to contraction of the compressor urethræ muscle ; introduce your left forefinger into the rectum and guided by it, insinuate the tip through the bulbous into the membranous portion. (*vi*) In the prostatic portion and its opening into the bladder ; *if the prostate is enlarged, finger in the rectum will be helpful* as a guide.

CHAPTER XXIV.

OPERATIONS ON THE GENITO-URINARY TRACT.—(*Contd.*)

THE PENIS.

Circumcision.

In this operation a redundant portion of the prepuce is removed.

Indications.—

(1) For phimosis with a small aperture.

(2) Para-phimosis. ·

(3) For the proper treatment of gonorrhœa with phimosis.

(4) Ulcers of the prepuce, *e.g.*, chancre, etc.

(5) Tumours of the prepuce, non-malignant or malignant.

Operation.—Circumcision can be performed in two ways :—

(*a*) *First method.*—Draw the prepuce slightly forwards, clamp it with a suitable pair of forceps in an oblique fashion, sloping from above downwards and forwards in order to leave sufficient skin on the under-surface of the penis to cover the raw triangular area which is produced. Shave the foreskin off in front of the forceps with a sharp knife or scissors and remove the forceps. The mucous membrane is left rather long after this ; slit it with a pair of scissors on the dorsum and remove sufficient quantity of it to meet the cut edge of the skin. The dorsal and the frenal vassels which are cut have to be secured ; bring the cut edges of the skin and mucous membrane together by stitches.

(*b*) *Second method.*—Slit the fore-skin up the dorsum of the penis with a pair of scissors to the level of the middle

of the glans. Carry the division round the penis taking the
same precautions on the under surface as in the previous
operation. Snip off any redundant mucous membrane and
bring the edges together.

Comment.—(1) When clamping the prepuce with
forceps do not clamp the apex of the glans with it and do
not clamp the prepuce too far back as proper allowance must
be made for retraction of the skin. (2) Do not remove too
much of the skin and mucous membrane from near the frænum,
as it will then leave a lozenge-shaped raw area. On the
other hand do not leave too much skin behind as it may give
rise to an unsightly lump there.

I.   Amputation of the penis.

Indications.—The penis is generally amputated for
malignant growths (epithelioma). It may on rare occasions
have to be amputated for chronic ulcers or other growths, *e.g.*,
papilloma when it is suspected that they are undergoing
malignant changes.

Instruments.—Group XXVI.

Amputation of the penis may be partial or complete.

1.   Partial   amputation   of   the   penis.—Partial
amputation can be performed by circular method
or a flap can be cut from the dorsum or from the under-surface
of the penis. I have adopted the last named method as it
has advantages over the other two. By this method when
the flap from the under-surface is apposed to the dorsal skin
incision, the opening for the urethra is made in the large flap
and so it lies below the suture line. There is, therefore, no
chance of urine dribbling on to the sutures and thus infecting
the part.

Operation.—It can be described in the following three
stages :—

1. *Constriction of the penis.*—Constrict the penis by
tying an elastic band round it in front of the pubis and
scrotum (Fig. 82).

PLATE XXVIII.
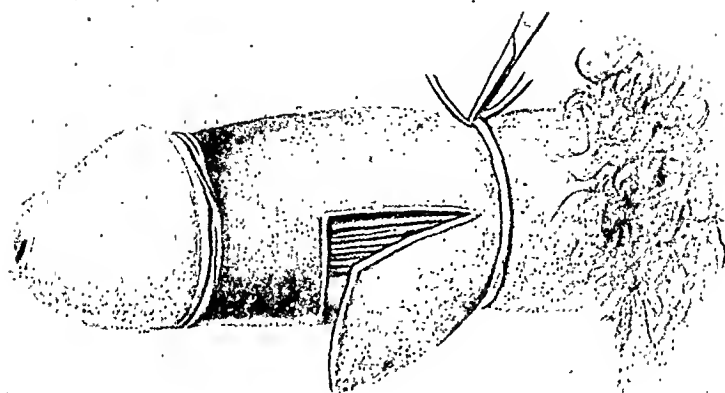
FIG. 82.
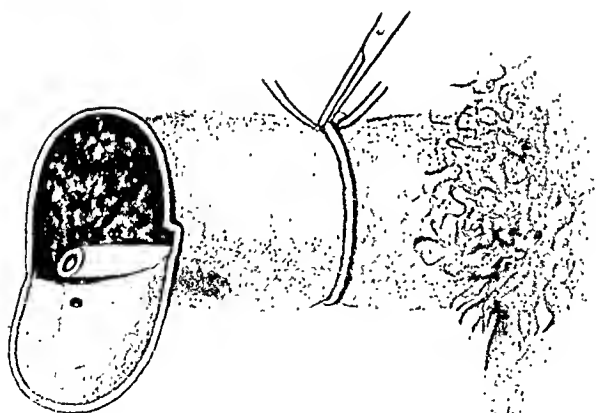
FIG. 83.

Amputation of the penis (Author's modification).

2. *The skin incision.*—Make an incision for unequal antero-posterior flaps with the long flap on the under-surface in such a way that the lower end of the incision is entirely free of any diseased tissue. Raise the flap from the under-surface without injuring the urethra and deepen the dorsal skin incision to the corpora cavernosa (Fig. 82).

3. *The section of the urethra.*—The assistant draws the penis up presenting the under-surface towards the operator. Dissect out about half an inch of the urethra from the corpus spongiosum in front of the future section of the corpora cavernosa and the corpus spongiosum. Cut across the urethra leaving enough to come through the future opening in the flap. Secure the urethra with a pair of forceps and cut through the body of the penis from below upwards commencing above the level of the urethra (Fig. 83). Remove the constricting band. The hæmorrhage from the corpora cavernosa and corpus spongiosum can be controlled by transfixion ligature (*vide supra*). Make a small puncture in the centre of the flap and pull the urethra through it ; slit it in the middle line and secure it to the edges of the puncture in the flap. Appose the lower flap to the dorsal skin incision. This completes the operation.

II. Complete amputation of the penis.

(Gould's method).

This operation is performed as follows :—Split the scrotum completely along the median raphe exposing the corpus spongiosum. Separate the corpus spongiosum from the corpora cavernosa up to the level of the triangular ligament passing a sound into the urethra, if necessary. Isolate the urethra up to the level of the triangular ligament ; carry the scrotal incision all round the root of the penis. Divide the suspensory ligament and separate the crura from the pubic bone ; slit the urethra and secure it to the scrotal wound. The vessels of the crura will need ligaturing.

CHAPTER XXV.

OPERATIONS ON THE GENITO-URINARY TRACT.—(*Contd.*)

THE TESTICLE AND ITS COVERINGS.

Surgical Anatomy.—The *scrotum* is the pendulous bag which contains the testes. Its skin is dark in colour particularly in tropical people. Its raphe extends from under the penis in front towards the anus behind. Its superficial fascia which is devoid of fat contains muscular tissue, the dartos ; the contraction of this muscle diminishes the size of the scrotum and its laxity renders it pendulous. The dartos forms a mesial septum dividing the scrotum into two compartments, each containing the corresponding testicle and its adnexa. There is a loose arœlar tissue underlying the dartos which contains blood-vessels and lymphatics.

The testicles.—The testes consist of the body and epididymis, the latter being divided into a globus major (the head), globus minor (the tail) and an intermediate portion ; it lies in the posterior aspect of the body of testes.

The spermatic cord—extends from testis to the internal abdominal ring. It consists of the vas deferens with its artery and veins lying posteriorly. The spermatic artery lies in front of the vas and the cremaster ramifies in the superficial tissues of the cord. The veins of the cord form a plexus, the spermatic or pampiniform plexus which accompanies the spermatic artery. There are numerous lymphatics of the cord draining into the lumbar glands and the cord contains genital branch of genito-crural nerve and sympathetic twigs.

Coverings of the cord and testes.—The testes and the cord derive the following coverings from the abdominal wall. From the external oblique, the external spermatic or intercolumnar fascia, from the internal oblique, the cremaster muscle and fascia from the transversalis fascia, the internal spermatic or infundibuliform fascia. The testes have a covering of a serous sac, the tunica vaginalis, originally derived from the peritoneum. It consists of two layers, the visceral and the parietal, between which is a potential space, the cavity of the tunica vaginalis. Under normal conditions, the sac of the tunica vaginalis is separated from the peritoneal cavity for the whole extent of the inguinal canal. The following abnormal conditions may, however, be present :—(1) The congenital type, in which the sac of the tunica vaginalis communicate with the general peritoneal cavity through a patent funicular process. If fluid accumulates in such a sac it is called *congenital hydrocele*. (2) The infantile type, in this the funicular process becomes obliterated near the internal abdominal ring ; a collection of fluid in the tunica vaginalis extends up the cord into inguinal canal and is known as *infantile hydrocele*. (3) The funicular type, the funicular process is closed at its lower end. Fluid distending this space produces a sausage-shaped swelling in the inguinal canal. This produces *a hydrocele of the funicular process* and may be mistaken for inguinal hernia.

Tapping a hydrocele.

Hydrocele can often be tapped as a palliative measure. Sometimes repeated tappings have been reported to cause a permanent cure. It is also tapped in cases where a more radical operation is contra-indicated either due to old age or cardiac, pulmonary and renal diseases ; even for most of these cases the radical operation can be performed under local anæsthesia. Tapping is contra-indicated in cases where the hydrocele sac communicates with the peritoneal cavity through an opening (congenital hydrocele).

Operation.—Select a point in the scrotum a little above the centre of the swelling and free from superficial veins. Make a small puncture with the point of a knife to facilitate the introduction of the trocar and canula. Keep in mind the posterior situation of the testicle. Make the hydrocele tense with the left hand and with the right plunge the point of the trocar, with the canula in a backward and upward direction through the skin puncture for a short distance into the sac of the tunica vaginalis. Withdraw the trocar and push the canula a little further in. Let all the fluid drain out slowly. When evacuation is complete pinch the sac and the scrotum on the canula and draw it out.

Comment.—It is best to support the scrotum by a bandage as the sudden relief of pressure may cause pain and it may also cause a certain amount of oozing from the wall of the sac in some cases. The puncture can be dressed with collodium and cotton wool.

Operations for the cure of the hydrocele.

The operation for the radical cure of hydrocele should have the following objects in view :—(1) Removal of the fluid in the sac. (2) Prevention of the re-accumulation of fluid. (3) Reduction of the size of testicle and scrotum so that the part may attain as much of its normal size and contour as possible. (4) Attainment of the above results with as little disturbance of the anatomical relations of the part as possible.

Indications.—

(1) For patients who are desirous of entering public services.

(2) It is a source of disfigurement in an awkward situation.

(3) To relieve a sense of weight and dragging pain that are caused by it ; these prevent the patient from taking physical exercise.

(4) Hydrocele is often a predisposing factor in the causation of hernia, varicocele, lymphangiectasis and elephantiasis.

(5) Any accidental trauma may give rise to hæmatocele or any infection may lead to suppuration in the sac.

Instruments.—Group XXVIII.

Position.—Dorsal position with the thighs kept apart.

Operation.—Following operations are more commonly practised for the cure of hydrocele.

A. Excision of the sac (Bergmann).—The operation can be described in three stages :—

(1) *Skin incision and exposure of the sac.*—Make a vertical incision about three inches long through the skin extending from near the spine of pubis. Expose the sac by separating it from all its covering by blunt dissection and gauze-wiping.

(2) *Treatment of the sac.*—Open the sac and trim it off close to the testicle ; apply a continuous suture all along the cut margin of the sac to stop oozing which is not inconsiderable.

(3) *Closure of the wound.*—Close the inguino-scrotal wound by interrupted sutures with or without drainage.

B. Eversion of the sac (Jaboulay).—

(1) *Skin incision and exposure of the sac* as in the previous operation.

(2) *Treatment of the sac.*—Open the sac, turn it inside out and secure it behind the testicle by bringing together its cut edges by a few interrupted catgut stitches. Return the sac and testicle into the scrotum.

(3) *Closure of the wound.*—As in the previous operation.

C. Lymphangioplasty or internal drainage (Chatterji).

Instruments.—Group XXX.

Operation.—Make a small puncture in the skin of the scrotum a little below the middle of the hydrocele. Introduce the trocar and canula into the sac, withdraw the trocar and let the fluid drain ; while the fluid is escaping, introduce a needle threaded with silk into the canula. (Fig. 84). Puncture
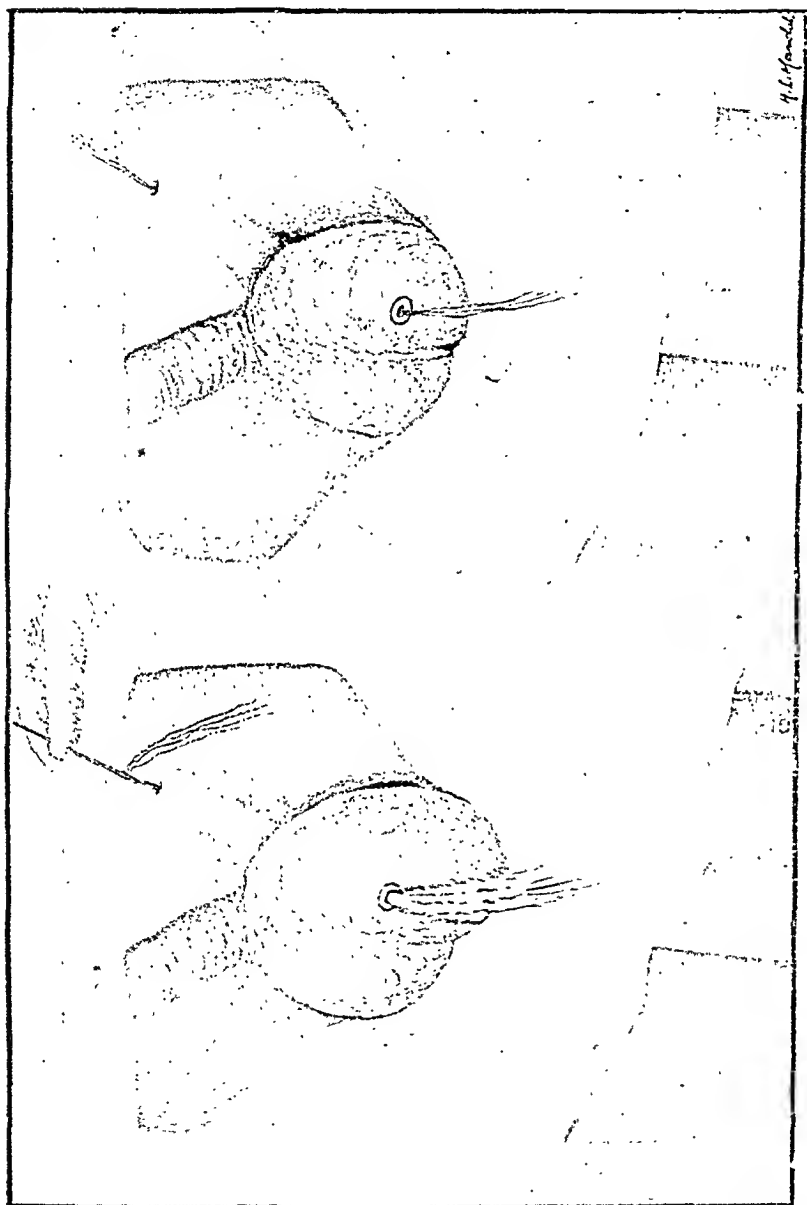
FIG. 84.   FIG. 85.

Hydrocele-lymphangioplasty (Chatterji).

the parietal layer of the sac on its inner aspect with the needle and insinuate the needle between the sac and subscrotal tissues upwards (subcutaneously) towards the inguinal region and further up. After the needle has travelled a sufficient length, puncture the skin from inside and pull the needle out. Cut off the silk and let it be retracted under the skin. Repeat the process in a downward direction towards the free end of the scrotum and also laterally. Always cut the ends of the silk flush against the skin at the point of emergence from it. Work a short length of the silk through the canals into the sac. These points can be sealed, if necessary (Fig. 85).

D. Plication and overlapping of the sac (Chatterji).

1. *Skin incision and exposure of the sac.*—As in other operation (excision of the sac) (Fig. 86).

2.. *Treatment of the sac.*—Make a full length incision into the sac. The testicle and the sac need not be delivered out of the scrotum. Roughen the visceral and parietal layers of the sac by means of a rough dry gauze or a spoon. Take one half of the sac, draw it across the testicle and fix by a few sutures to the line of reflection of tunica vaginalis from the testicle (Fig. 87). Treat the other half of the sac similarly, but let it overlap and be transplanted on the superficial aspect of the first half of the sac (Fig. 88). If the sac is large and redundant, I plicate it particularly at the upper and lower parts (Fig. 88).

3. *Closure of the wound.*—As in previous operations.

Comment.—Judging from the nature of the operation the methods Nos. 3 and 4 satisfy the conditions laid down for the cure of hydrocele. Lymphangioplasty is suitable for smaller hydroceles. Plication and overlapping of the sac is suitable for practically all hydroceles. In the case of those with very large sacs, portions of it can be excised. In the case of much thickened sacs the cartilaginous thickening
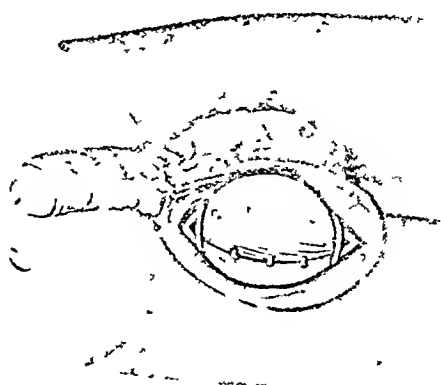
Fig. 88.
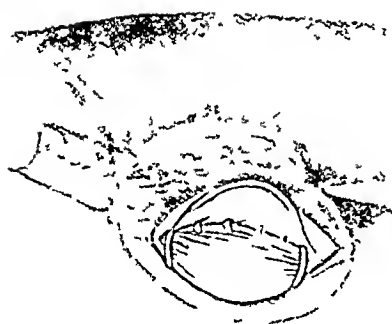
Fig. 87.
Plication and overlapping (Chatterji)

Fig. 86.

Radical cure of Hydrocele by plication.

may be removed with scissors or a fine scalpel. In the first two methods the hydrocele looses its natural covering and lies exposed anteriorly. By the eversion method the antero-posterior diameter of the testicle is much increased. All these drawbacks are avoided if the operation is performed according to the fourth (author's) method.

Castration.

Indications.—Excision of the testicle as a whole is indicated in the following conditions :—

(1) Tumour of the testicle. In some cases of non-malignant tumours and in all cases of malignant tumours so long as the spermatic cord is not extensively involved.

(2) Tuberculous disease of the testicle. ·

(3) Some cases of syphilitic disease of the testicle where it is disorganised by gummatous changes beyond recovery. This is rarely done now.

(4) In old hæmatoceles in which due to pressure or otherwise, the testicle has been atrophied and is an useless appendage and also if septic infection has taken place.

(5) In cases of retained testes : (a) where it cripples the patient due to repeated inflammation ; (b) when there is torsion of the cord ; (c) when it is associated with hernia and the operation of radical cure of hernia cannot be done without removing the testicle.

(6) In cases of elephantiasis of the scrotum where the testicle is atrophied from pressure and hopelessly adherent to the scrotal and subscrotal tissues. Lymphangiectasis of the spermatic cord.

(7) In former days castration used to be performed for enlarged prostate and after amputation of the penis, but the object for which this was practised can be attained by vasectomy.

Instruments.—Group XXVII.

Operation.—Make an incision skin deep three half inches long, from the spine of the pubis upwards and outwards just

above Poupart's ligament parallel to it and to a point which is on a level with its middle. Feel for the cord and draw the testicle out from the scrotum through the wound. Separate its attachments to subscrotal tissues if any. The testicle is now free. The cord is secured as high as possible with a Staffordshire knot or by transfixion ligature (*vide supra*), and it is cut across a little distal to it.

Comment.—Before removing one testicle, make sure that the other testicle can supply the internal secretion and retains its physiological function.

Operation for Varicocele.

Indications.—The indications for the removal of the pampiniform plexus of veins of the spermatic cord for their varicose condition are as follows:—

(1) When the varicosity is steadily increasing, causes distress, annoyance and pain.

(2) Where it interferes with the usual pursuit of life and legitimate physical exercise.

(3) When the patient desires to enter public service and is debarred from it.

(4) When the testicle is undergoing atrophy.

Instruments.—Group II.

Position.—Dorsal position.

Operation.—Make an incision in the inguinal canal a finger's breadth above and parallel with the inner third of Poupart's ligament. Divide the tissues till the cord is exposed. Pick up the whole mass of the cord and isolate it from the external abdominal ring to the testicle. Feel for the vas deferens and separate it with its artery vein and if necessary one more vein from the remaining mass of pampiniform plexus of veins. Apply crushing forceps to this plexus proximally at the external ring and distally near the testicle. Remove the clamps and apply catgut ligature on the groove left by these, keeping the ends of the ligature long. Remove the intervening portion of the veins between these ligatures.

Appose the venous stumps by means of the long ends of the ligatures.   Close the wound with or without a drain.

  Comment.—High incision is useful as the cord is more accessible in the inguinal region and there is less chance of sepsis.   The venous stumps are brought together to reduce the length of the cord.   If the scrotum is pendulous, a portion of it may be excised so that the small scrotum may lend a better support to the testes.

CHAPTER XXVI.

OPERATIONS ON THE BREAST.

Surgical Anatomy.—The female breast consists of the parenchyma or gland tissue supported by a stroma or connective tissue framework and the circummammary fat. These three collectively form corpus mammæ or the mammary gland. It is embedded in the superficial fascia of the chest-wall. It extends vertically from the lower border of the second rib to the lower border of the sixth costal cartilage, and horizontally from edge of the sternum to the mid-axillary line. The pectoral fascia separates it from the pectoralis major (partly), pectoralis minor, serratus anticus and obliqus externus muscles.

It receives its blood supply from the thoracic branches of the axillary and perforating branches of the external mammary and intercostal arteries.

The lymph vessels are arranged in two groups, the cutaneous and the glandular. The cutaneous group arise from two plexuses, the subareolar plexus (Sappey) in the central part and the fascial plexus in the peripheral part. The glandular lymphatics arise from the perilobular connective tissue and following the course of the milk-ducts enter the subareolar fascial plexus of the skin. The lymphatics anastomose freely with the neighbouring lymphatics; this fact explains the spread of breast cancer to other parts. For instance, in the middle line, the lymphatics anastomose with those of the opposite side. In the epigastric region they communicate with the lymphatics of the parietal wall and parietal peritoneum. Some lymphatics accompany the intercostal vessels of the spine. The lymphatic vessels pass in different directions to various glands, namely the axillary gland along

axillary vessels; the pectoral glands between the pectoral and serratus anticus muscles on the anterior border of axilla; the subscapsular glands along the posterior border of axilla, the infra-clavicular, supra-clavicular glands, the sternal and mediastinal glands.

Suppurative mastitis or mammary abscess.

Mammary abscesses may be grouped into three classes according to their situation. A *pre-mammary abscess* is a collection of pus under the areola. It is a superficial abscess and should be treated by a simple incision in a radiating manner. An *inter-mammary abscess* lies in the substance of the breast and may burrow in different directions to form a multi-locular abscess cavity. These abscesses are not infrequently seen in both the breasts.

Operation.—A free incision radiating from the nipple, with counter-openings for free drainage. Any septa inside the abscess cavity should be broken down with the finger. The ducts must not be cut across. In some cases with sinuses, etc., it may be necessary to excise a wedge-shaped segment of the breast including the sinuses; if the breast is much disorganised its complete excision may be necessary.

Retro-mammary abscess, i.e., collection of pus in the areolar tissue between the breast and the pectoral muscles.

Operation.—The abscess is opened by a free incision in the mammary-thoracic fold.

Excision of the breast.

The radical operation for breast cancer entails the removal *en masse* of the following tissues :—(a) the entire mammary gland with a sufficient amount of overlying skin ; (b) an extent of the deep thoracic fascia limited above by the clavicle, internally by the mid-sternal line, externally by the mid-axillary line, below to the tip of the ensiform cartilage; (c) the sterno-costal portion of the pectoralis major and pectoralis minor muscles ; (d) the lymphatic glands, fat and connective tissue

PLATE XXXI.
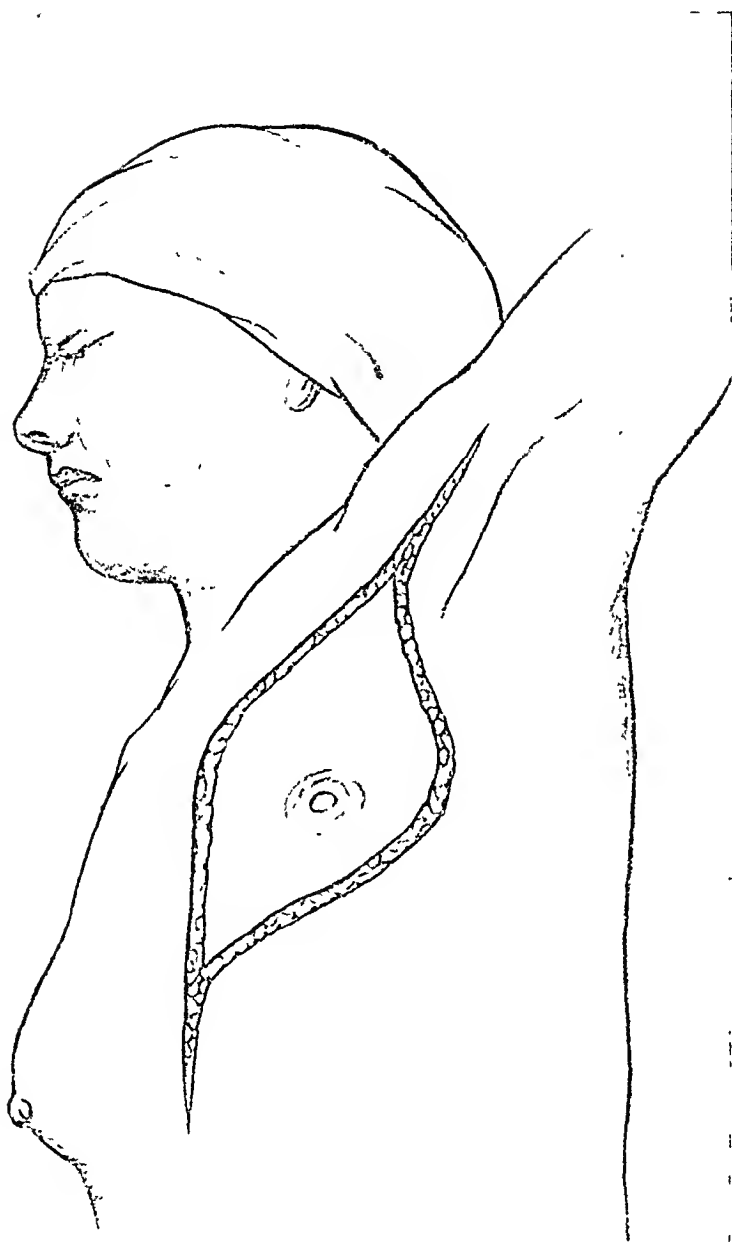
FIG. 89.
Excision of the breast.

extending below from the axilla surrounding the vessels and nerves to beyond the first rib, where the axilla communicates beneath the clavicle with the root of the neck.

Instruments.—Group II.

Position.—Dorsal position. Raise shoulder slightly and support them by a sandbag, the arm being abducted to a right angle. The operator stands on the side to be operated, between the arm and the trunk, the assistant stands opposite to him on the other side of the arm near the shoulder.

Operation.—The operation will be described in six stages :—

(i) *The skin incisions.*—The incision takes the shape of an ellipse with two limbs at its far ends. The upper of the two limbs is extended upwards and outwards in a curved direction over the anterior axillary fold to the upper part of the arm. The lower limb is prolonged downwards and inwards to a point in the middle line, about two inches below the tip of the ensiform cartilage. The shape of the ellipse proper will be fashioned according to the particular quadrant of the breast that is involved in the growth. These incisions cut into the skin and subcutaneous fat (Fig. 89).

(ii) *Exposure of the axilla and its contents.*—Reflect the skin over the axilla with the subcutaneous fatty tissue by dissecting down the lower limb of the incision. Expose and define the margin of the latissimus dorsi tendon. Divide the deep fascia in the line of the incision ; this exposes the axillary vessels and brachial nerves.

(iii) *Exposure of the inner area and division of the pectoral muscles.*—Reflect the skin from the upper limb of the incision in a similar manner. This exposes the area from subclavicular region to mid-sternal line. Define the interval between the clavicular and costo-sternal portions of the pectoralis major, introduce the index finger from below, underneath the pectoralis major, between it and the axillary vessels and divide the muscle close to the humerus ; retract the cut muscles towards the chest. The pectoralis

minor and the costo-coracoid membrane are brought into view ; introduce the index finger under this muscle and divide it close to its insertion into the coracoid process. The axilla is now exposed in its full extent.

(iv) *Clearing of the axilla of connective tissue, lymphatics and lymphatic glands.*—The axillary vessels and large nerve trunks are invested by a quantity of loose fatty tissue and a membranous layer which forms a sheath containing numerous lymphatic vessels. Commencing at the outermost part of the wound, strip this membrane, taking with it the loose axillary tissue, the lymphatics and the lymphatic glands, off the nerves and vessels. This is best done by blunt dissection and gauze-wiping. Branches of axillary vessels as they come have to be divided. On reaching the apex of the axilla, glands will be found in relation to the axillary vein, another chain of glands will be found behind the main vessels in the space between the subscapularis, externally and serratus magnus, internally ; all these glands have to be included in the entire mass which is dissected out from the axilla. This mass with the two pectorals which have been divided are drawn inwards. The clearing of the axilla is now complete.

(v) *Detachment of the breast*—together with its investing fatty tissue, the pectoral muscles and the deep fascia. The assistant draws up the dissected mass with the breast towards the middle line. Commence by reflecting the superficial tissues at the outer side of the elliptical incision. Carry the knife deeply into the fatty tissue to make sure that no portion of the mammary gland tissue is left behind ; under-cut this flap up to the mid-axillary line in such a manner that the deep fascia covering the serratus magnus and the upper digitations of the external oblique are exposed. Turn to the sternal side of the incision. The assistant carries the breast across to the outer side, detach the superficial tissues from the infra-clavicular and upper sternal regions downwards and towards the mid-sternal line. Put the

forefinger in the interval between the two divisions of the pectoralis major which has already been defined, and divide this muscle from its costo-sternal attachments close to the sternum. The assistant draws all the divided structures with the breast further away from the chest wall. Divide the attachments of the pectoralis minor to the third, fourth and fifth ribs. To free the breast from the chest, detach the deep fascia from the underlying muscles, namely serratus magnus, external oblique and rectus abdominis as far down as the lower limit of the incision in the substernal region.

(*vi*) *Apposition of the skin.*—This operation leaves rather an enormous wound and the edges of the skin can hardly be brought together ; much can be done, however, by undercutting the skin all round and by bringing the arm to the side.

Comment.—(1) Hæmorrhage. A large number of vessels are cut in this extensive operation. In the second and third stages, the axillary vein must be carefully guarded ; if it is hopelessly adherent to the glands, a portion of it may have to be excised under compulsion. The knife should be sparingly used. Wiping with gauze-covered fingers is less risky. Near the costo-coracoid membrane some branches of the thoracic axis are cut. In the fourth stage, some branches of the axillary vessels from the main trunk have to be divided. In the fifth stage some vessels have to be cut during deep dissection at the outer side of the elliptical incision. At the costo-sternal junction, perforating branches of the internal mammary artery are divided. In the living subject they are liable to retract, so they should be clamped before division. (2) Nerves. The brachial cords and their larger branches should not be injured. In the fourth stage, the posterior thoracic nerve supplying the serratus magnus and in relation to its outer surface and the long scapular running along the posterior wall of the axilla to pierce the latissimus dorsi, should be preserved. The intercosto-humeral nerve may have to be cut. (3) Throughout the operation keep rigidly clear of mammary gland substance.

Partial excision of the breast.

In cases of (*a*) localised mastitis of parenchymatous or interstitial variety ; (*b*) localised tuberculous deposits ; (*c*) simple cysts or non-malignant tumours of the breast which have been confirmed by diagnosis, the tumour can be excised or the whole of the mammary gland may have to be removed. This can be performed by an incision preferably on the inferior aspect of the breast. If the whole breast has to be removed it can be done by an incision round the outer limit of the breast and then undermining the skin in the line of the incision and removing the gland without interfering with the fascia and muscles.

CHAPTER XXVII.

TROPICAL SURGERY.

ELEPHANTIASIS.

Filarial infection often gives rise to conditions necessitating surgical interference. Some of the chief manifestations caused by filarial infection are :—

1. Elephantoid fever.
2. Lymphangitis.
3. Funiculitis and orchitis.
4. Filarial abscess.
5. Lymphangiectasis of the cord and of the scrotum.
6. Phlebectasis.
7. Elephantiasis of the scrotum, penis, vulva, extremities and other parts.
8. Chylocele, chylous ascites and chyluria.
9. Filarial affection of joints.

Elephantiasis of the scrotum.

Indications.—Operation is indicated in the following conditions :—(1) It is an encumbrance to the patient. (2) Physical and sexual disabilities. (3) Liability to septic infection and suppuration.

Instruments.—Group XXIX.

Position.—Dorsal position with the operator on right side of the patient or lithotomy position.

Operation.—

(i) *The penis.*—Make a median vertical incision through the elephantoid tissue of the penis, commencing above at the pubo-penile junction to the prepuce. Get the penis free of all elephantoid tissue by peeling it off its substance and cover it with gauze and rest it on the pubis.

(ii) *The scrotum.*—Make a curved incision along the

PLATE XXXII.
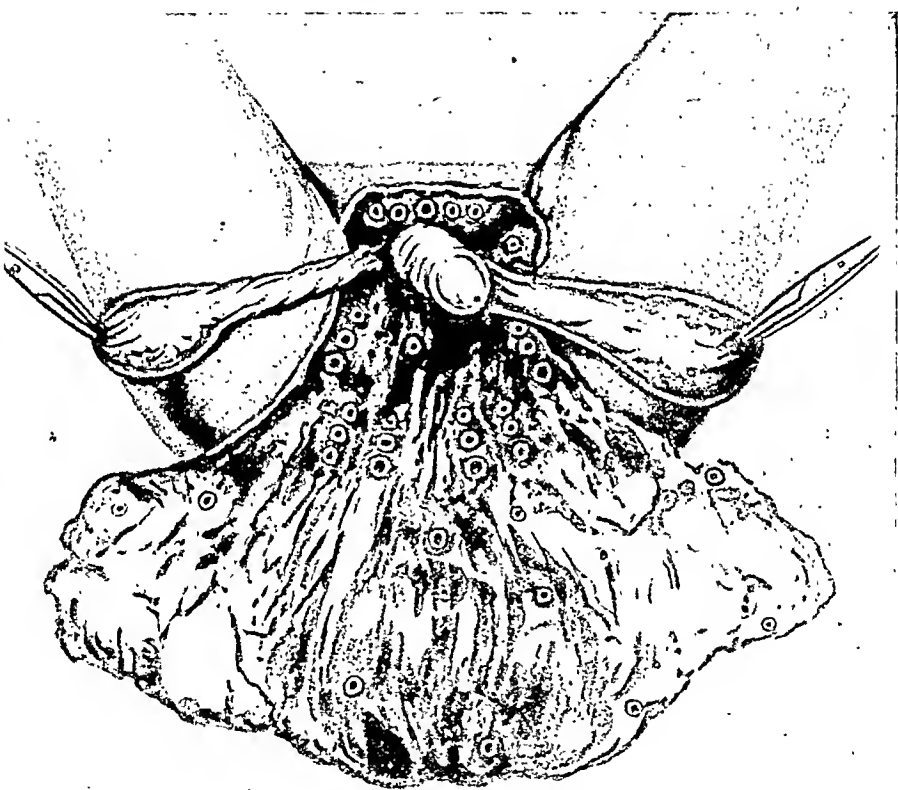
FIG. 90.
Excision of the elephantoid scrotum.

neck of the tumour. Deepen this incision with the aid of scalpel and scissors. The lower end of these incisions meet in the middle line in front of the anus. From the middle point of the incision in front, make two lateral vertical cuts through the substance of the growth in the line of the cords, till the cords and testis are exposed. Deliver the testicles after detaching their attachments with the lowermost part of scrotum. If the sac of tunica vaginalis contains any fluid (hydrocele) it should be treated by eversion or plication (Fig. 90) (*iii*) *Making and suturing of the flap.*—Pull the free edge of the flaps forward and elevate them in order to obtain sufficient space for tucking in the testicles. Appose these scrotal flaps by bringing them together with tissue-forceps and then applying interrupted sutures : stitch the penis flaps to the fibrous sheath covering the erectile tissue of the penis ; any uncovered part of the penis will require skin-grafting (Fig. 91).

Comment.—1. The following vessels will have to be secured ; superior and inferior external pudic vessels, superficial perineal vessels, cremasteric vessels and artery to the frenum. 2. The wound should be drained with a few strands of silkwormgut.

Elephantiasis of the labium.

The labia majora, minora, the clitoris and the adjoining parts may be affected with elephantiasis.

Position.—Lithotomy position.

Operation.—Commence a skin incision below at a point beyond the growth and carry it upward to a point beyond the upper limit of the growth. Make a similar incision through the mucous surface of the vagina on the same side and let it meet the skin incision. Now remove the growth by deepening the incision from either side and appose the cut surfaces by silk or catgut sutures. If the other labium is also affected it should be treated in a similar way.

Comment.—A few vessels that are divided can be easily secured by under-running ligatures (sutures) of catgut.
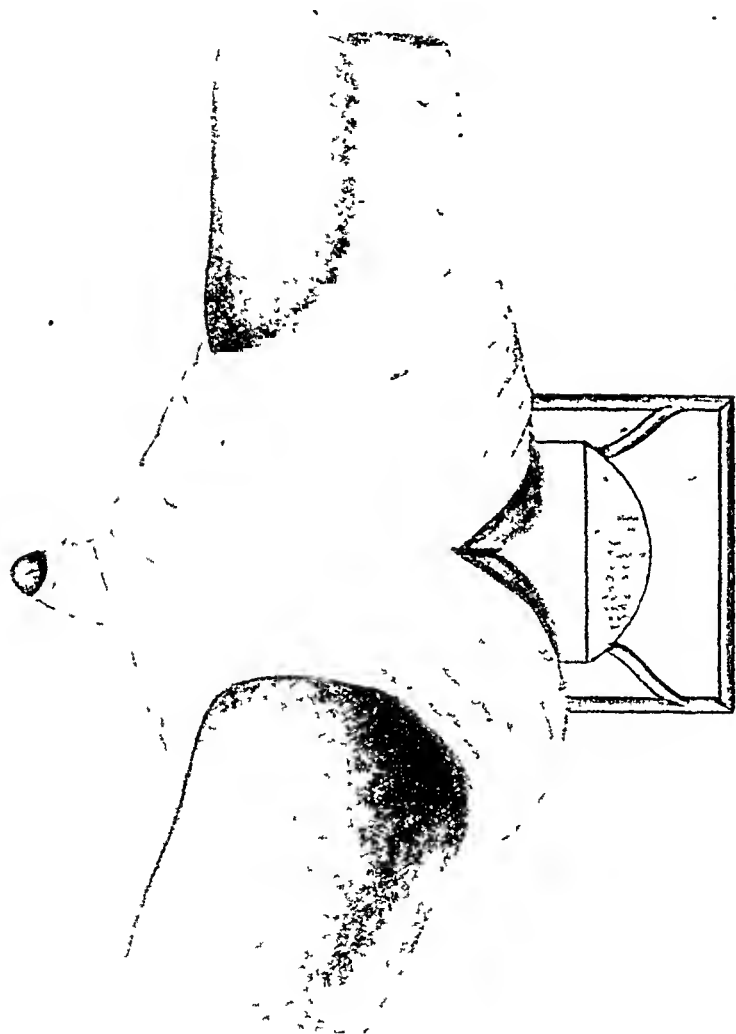
Excision of Elephantoid scrotum - bandaged.

Fig. 91.

CHAPTER XXVIII.

TROPICAL SURGERY—(Contd.)

AMŒBIC SUPPURATIVE HEPATITIS :
(Tropical Liver Abscess.)

Surgical Anatomy of the liver. *Vide supra* (Fig. 92).

Suppuration in the liver may be treated according to one of the following methods :—

1. Aspiration.

2. Aspiration and injection.

3. Aspiration and irrigation (author's method).

4. Open method. (*a*) Trans-pleural route. (*b*) Subcostal route.

5. Author's modification. (*a*) Klapp-suction. (*b*) Continuous irrigation.

Indications for operative interference.

1. Bulging and obliteration of intercostal space.

2. A localised bulging in the subcostal space.

3. Superficial local œdema with pitting on pressure.

4. Increased pain and tenderness.

5. Progressive enlargement of liver.

6. Temperature assuming hectic type.

7. Screen examination (radioscopy) reveals higher level of the right dome of the diaphragm and impaired respiratory movement of the diaphragm.

8. Blood examination shows increasing leucocytes.

9. Exploratory puncture with positive results.

10. Injections of emetine relieved the pain to a certain extent but none of the other features.

PLATE XXXIV.
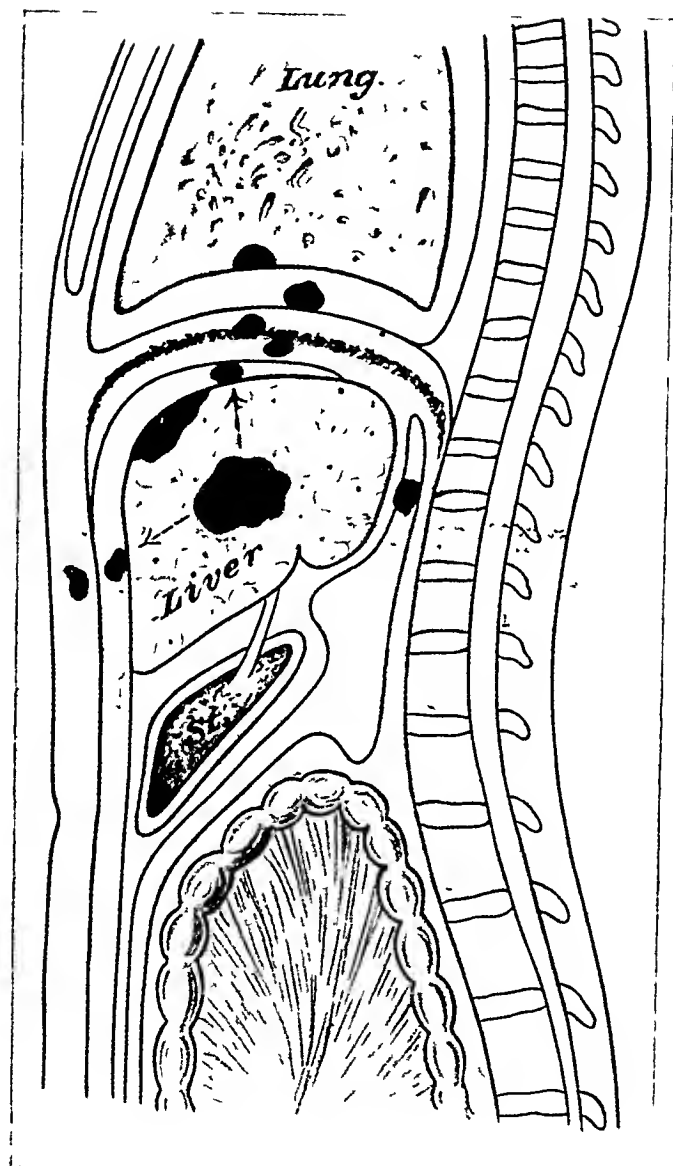
FIG. 92.
Schematic diagram of suppurations in the liver.

Instruments.—Groups XII and VII.

Position.—Dorsal or dorso-lateral position with operator on the right side of the patient.

Operations.—

1. *Aspiration.*—Select the site of the puncture generally in the mid-axillary line in the right of the space. Make a small puncture with a sharp scalpel and introduce the trocar and canula of the aspirator firmly, then withdraw the trocar and evacuate the pus into the aspirating bottle. Repeat the process till the abscess is thoroughly evacuated. (Fig. 93).

2. *Aspiration and injection.*—After the liver abscess has been thoroughly evacuated quinine solution (10 grs. to an oz.) or emetine solution (½ gr. to an oz.) can be injected.

3. *Aspiration and irrigation.*—After evacuating the abscess cavity I use 5 per cent. solution of iodine in bi-sterilised distilled water for irrigation. Latterly, I have been using eusol followed by iodine solution (5 per cent.) with very good results. (Fig. 93).

4. *Open Operation.*—Liver abscess should be opened by trans-pleural or subcostal routes according to their situation.

(a) *Trans-pleural route.*—Determine the position of abscess if necessary and resect a portion of a rib (*vide supra*) according to indications. If adhesions between the liver and diaphragm have been formed, open the abscess at once. If no adhesions have formed, induce adhesions between diaphragm, liver and parietes either by passing sutures through these structures or by packing gauze circularly round the proposed opening in the liver. The abscess can be opened after 24 to 48 hours.

(b) *Subcostal route.*—For abscesses which have bulged in the subcostal region, the same procedure is to be adopted as for the previous operation. No rib has to be resected and in the absence of pre-existing adhesions, these have to be induced between the liver, peritoneum and abdominal parietes.

PLATE XXXV.
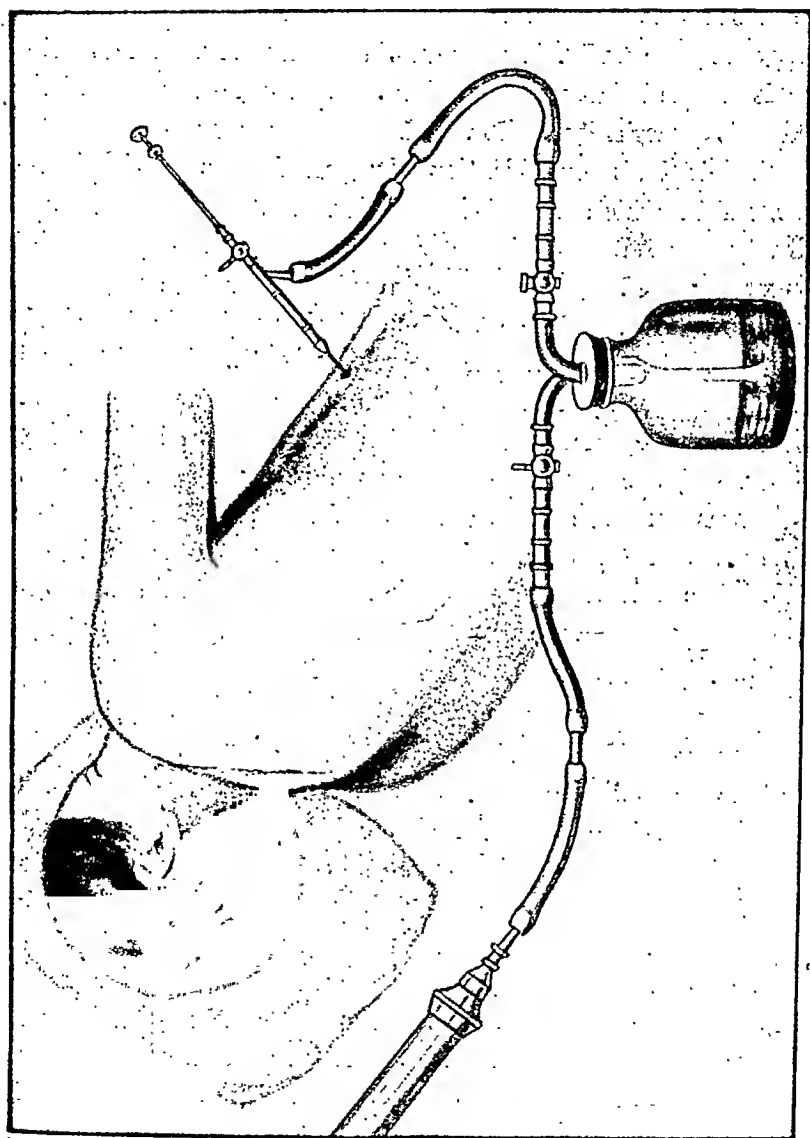
Fig. 93.

Aspiration of the liver abscess.

5. *Author's modification by drainage and suction by Klapp-suction apparatus.*—After the abscess is opened, I apply a Klapp-suction cup of suitable size and shape till the abscess is completely evacuated, then I introduce an empyema tube and a fairly voluminous dressing. The suction cup is applied daily till the discharge becomes serous and the cavity is practically obliterated.

6. *Author's modification by continuous irrigation.*— In cases in which the Klapp-suction apparatus cannot be suitably applied, I treat the abscess by continuous irrigation for 24, 48 and 72 hours. I introduce two drainage tubes into the cavity. The longer one reaching the depth of the cavity and the shorter one to a lesser depth. The former is used as an introducing tube and is connected to the douche-can, containing the antiseptic fluid by means of an india-rubber tubing. The other tube serves as a returning tube for the discharges and the fluid, and to this is attached another tubing which ends in a bottle containing some antiseptic fluid. The thickness of the pus is reduced within 24 hours after which I change the tubes for my capillary drainage system. (Fig. 53).

Comment.—

The indications and merits of the different methods of operation can be summarised as follows :—

Aspiration is suitable for abscess of the right lobe which could be evacuated. Secondary infection and sepsis can be easily prevented by this method. The two drawbacks of this method are, that if the pus is thick, its complete evacuation is not possible by means of ordinary evacuating canula, and that repeated aspirations are sometimes necessary. These objections can be overcome by my method of aspiration and irrigation. Other advantages of this method lie in the fact that the operation can be performed with the minimum of shock and the patient does not need to be dressed for a long period, a measure which is exhausting to the patient.

The advantages claimed by the open operation are that it is a better surgical method, the drainage is more efficient and a more satisfactory inspection of the abscess cavity can be made. The objections to this method are shock of operation, chances of secondary infections of the abscess cavity, and a protracted course of dressings which exhausts the patient. Most of these objections are overcome by my modified methods, namely, the use of Klapp-suction apparatus and continuous irrigation or a combination of both.

CHAPTER XXIX.

INTRAVENOUS INJECTION OF SALINE SOLUTION IN CHOLERA.

Indications.—In cholera there is a considerable loss of fluid from the blood and therefore from the tissues as it must be, due to frequent and copious purging and vomiting. This is strengthened by post-mortem findings. The loss of fluid can be determined by : (i) estimating the relative proportion of corpuscles and serum ; (ii) determination of specific gravity of blood ; (iii) the condition of the pulse which indicates different degrees of loss of tension ; this can be ascertained by the estimation of blood pressure ; (iv) loss of salts from the tissues and the blood, and (v) suppression of urine.

Methods of injection.—The choice of the method of administration of saline solutions are :—

1. *Intravenous saline transfusion*—for technique (*vide infra*). Intravenous injection of hypertonic saline is indicated when (a) blood pressure is at or below 70 m.m. ; (b) when sp. gr. rises above 1063. The quantity to be introduced may be from 3 to 6 pints according as the specific gravity ranges between 1063 to 1065. The injection has to be discontinued when blood pressure rises above 70 m.m. but should be repeated directly it falls below that. The temperature at which the saline solution is to be injected :—

	Rectal Temp.	Temp. of sol. at which it is to run in.	Approximate flask temp.
Below . .	99°F	102°F to 104°F	105°F
At or above .	99°F	98·4°F	100°F
Above . .	100°F	Below 98°F	99°F
Above . .	102°F	80°F to 90°F	95°F

2. *Rectal injection.*—Half a pint every two or four hours is indicated when there is collapse and insufficient excretion of urine. This should be continued till the patient recovers from collapse and passes two pints of urine in 24 hours.

3. *Subcutaneous injection*—is indicated when the specific gravity of the blood is above 1063 with a fairly high blood pressure, *e.g.*, 100 m.m. or more.

4. *The alkaline (hypotonic) saline solution*—should be given intermittently or concurrently with the above methods either intravenously or subcutaneously or per rectum as prophylactic against acidosis which is an important caustive factor of post-choleraic uræmia.

Composition of saline solutions :

A. Normal (isotonic) saline solution :—

sodii chloride	..	90 grains.
aqua destil	..	1 pint.

B. Hypertonic saline solution :—

sodii chloride	..	120 grains.
calcii chloride	..	4 grains.
potassii chloride	..	6 grains.
aqua destil	..	1 pint.

C. Alkaline (hypotonic) saline solution :—

sodii chloride	..	60 grains.
sodii bicarb	..	160 grains.
aqua destil	..	1 pint.

Technique of Intravenous Injection.

Instruments.—Group XXXIII.

Position.—Dorsal position with arm abducted and forearm supinated.

Operation.—Select any vein in the upper part of the forearm or at the bend of the elbow. Tie a rubber band or tourniquet round the arm securing it with a slip-knot. Make a superficial incision with a sharp scalpel, exposing about an

inch of the vein. Clear the vein of the surrounding tissues and introduce an aneurysm needle under the vein from one side to the other. Thread it with a long piece of silk or catgut. Pull the needle back leaving the two free ends of the ligature on either side. Cut the loop of ligature near the needle and withdraw it (needle). The vein has therefore two pieces of ligature running across it behind. Pull one piece (*a*) up, proximal to the future point of vene-section ; pull the other piece (*b*) down to a point distal to the future point of vene-section and tie it off with a surgical knot. With the upper ligature (*a*) pass one turn of a loose knot and leave it. Now with a pair of sharp scissors make a V-shaped incision into the vein with the apex of the V pointing distally. Quickly pick up the wall of the vein by means of V flap, and introduce the intravenous canula at once into the lumen of the vein, unloosening the rubber band round the arm. Complete the unfinished knot of the ligature by tying it round the vein with the canula in its lumen. Let the required amount of saline run in. Then withdraw the needle and while doing so tighten the ligature (*b*) obliterating its lumen. Complete the operation by closing the skin incision, either by silkwormgut or by Mitchell's clips.

    Comment.—(1). The saline solution must be at the required temperature.

    (2) Let the canula run a little before introducing it into the lumen of the vein in order to avoid all possibilities of introducing air.

CHAPTER XXX.

SELECTION OF INSTRUMENTS FOR OPERATIONS.
(Arranged in Groups.)

**I.—Instruments generally required for most opera-
tions.** Scalpel, artery forceps, dissecting forceps, scissors,
director, dissector, suture needles, straight and curved, wound
retractors, tissue forceps, sutures and ligatures and skin forceps.

II.—For ligation of vessels, etc. Aneurysm needles.
and Group I.

III.—For amputations. Tourniquet, periosteal elevator,
amputation knife, amputation saw, bone forceps, lion.
forceps, gouge, amputation flap retractors, gouge forceps and
Group I.

**IV.—For excision of bones and joints and bone-
suturing.** Tourniquet, excision knife, Gigli's saw with guide·
and protector, lion forceps, saw, periosteal elevator, spoon,
gouge, bone forceps, sequestrum forceps, bradawl, drill, chisel,.
mallet, gouge forceps, bone-suture needles and wire guide,
suture material and Group I.

V.—For sequestrotomy and osteotomy. Bone nippers,·
sequestrum forceps, raspatory, gouge, gouge forceps, periosteal
elevator, chisel, mallet, osteotome (McEwen's etc.), osteotomy·
saw, lion forceps and Group I.

VI.—For excision of the jaws. Gag, tooth forceps,
key-hole saw, Hey's saw or Horsley's saw and Group IV.

VII.—For resection of ribs. Rib-shears, Hey's or·
Horsley's saw, sequestrotomy forceps and Group IV.

VIII.—For trephining and operation on the skull.
Trephines, gouge forceps, skull forceps (De-vilibis, etc.),
periosteal elevator, bone forceps, gouge forceps, Gigli's wire-,
saw with guide and protector, fine toothed forceps and Group I.

IX.—For tonsillectomy. Gag, volsellum forceps, tonsil scissors, tonsil guillotines, tongue depressor, sponge holders, straight and curved, blunt pointed scissors and tonsil compression forceps.

X.—For tracheotomy. Blunt and sharp hooks, tracheotomy dilator, tracheotomy tubes and tape, a short narrow bladed scalpel; special forceps for removing foreign bodies and Group I.

XI.—For laryngotomy. Laryngotomy tube and Groups I and X.

XII.—For paracentesis. Exploring syringe, small scalpel, scissors, trocar and canula, aspirating trocar and canula, aspirating bottle and pump.

XIII.—For intestinal operations. Peritoneal forceps, intestinal clamps (Doyen's, etc.), abdominal retractors, intestinal suture needles, straight, curved and semi-curved (Murphy's button), and Group I.

XIV.—For operations on the stomach. Kocher's clamps and Group XIII.

XV.—For appendicectomy. Appendix crushing clamps and Group XIII.

XVI.—For colostomy. Glass rod, Paul's tube and Group XIII.

XVII.—For herniotomy. Hernia needles, large clamps, hernia director, peritoneal forceps, retractors, full curved Doyen's needle and Group I.

XVIII.—For operation for piles, etc. Pile clamps, rectal specula, needle holder, vulsellum forceps, curved needles, petticoat tube and Group I.

XIX.—For operations on gall-bladder. Cholecystotomy forceps, gall-stone scoop and Group XIII.

XX.—For operations on kidney. Pedicle clamp, retractors, renal calculus forceps, scoop, sound, pedicle needle, nephrectomy needle, nephrectomy scissors, fine trocar and canula, dilating lance forceps, fine pointed scissors, pus seeker, fine pointed director and Group XIII.

XXI.—For suprapubic cystotomy. Catheters, syringes, irrigation apparatus, hollow sound (Thomson's), sharp hook, long curved forceps, lithotomy forceps, straight and curved of different sizes, lithotomy scoops (stone), blunt hook, retractor, fully curved needles, needle holder, long bladed scalpel or straight bistoury, vulsellum, needles on handles with protected and concealed eyes and Group I.

XXII.—For litholapaxy. Lithotrites of different sizes, evacuators, evacuating canulæ of assorted sizes, sounds irrigation apparatus, rubber tube, Jacque's catheter.

XXIII.—For prostatectomy. Same as in Group XXI.

XXIV.—For internal urethrotomy. Internal urethrotome, catheters, syringe, bougies.

XXV.—For external urethrotomy. Wheelhouse staff, long straight bistoury, Teal's probe-pointed director, probe gorget, median grooved staff, Syme's staff, perineal tube, (metallic) of different sizes and Group I.

XXVI.—For amputation of the penis. Fine toothed forceps, rubber tube, clamps, curved needles, Jacque's catheters and Group I.

XXVII.—For castration. Clamps, dissector and Group I.

XXVIII.—For operations on hydrocele. Scraper, spoon and Group I.

XXIX.—For elephantiasis. Retractors, clamps, tissue forceps and Group I.

XXX.—For lymphangioplasty : for hydrocele. Medium size trocar and canula, long and straight needle, silk and catgut and Group I.

XXXI.—For subcutaneous tenotomy. Sharp or blunt pointed tenotome, sutures.

XXXII.—For open tenotomy. Blunt hooks and Group I.

XXXIII.—For intravenous injection. Canula, india-rubber tubes, graduated flasks, elastic tubes, aneurysm needles and Group I.

IX.—For tonsillectomy. Gag, volsellum forceps, tonsil scissors, tonsil guillotines, tongue depressor, sponge holders, straight and curved, blunt pointed scissors and tonsil compression forceps.

X.—For tracheotomy. Blunt and sharp hooks, tracheotomy dilator, tracheotomy tubes and tape, a short narrow bladed scalpel; special forceps for removing foreign bodies and Group I.

XI.—For laryngotomy. Laryngotomy tube and Groups I and X.

XII.—For paracentesis. Exploring syringe, small scalpel, scissors, trocar and canula, aspirating trocar and canula, aspirating bottle and pump.

XIII.—For intestinal operations. Peritoneal forceps, intestinal clamps (Doyen's, etc.), abdominal retractors, intestinal suture needles, straight, curved and semi-curved (Murphy's button), and Group I.

XIV.—For operations on the stomach. Kocher's clamps and Group XIII.

XV.—For appendicectomy. Appendix crushing clamps and Group XIII.

XVI.—For colostomy. Glass rod, Paul's tube and Group XIII.

XVII.—For herniotomy. Hernia needles, large clamps, hernia director, peritoneal forceps, retractors, full curved Doyen's needle and Group I.

XVIII.—For operation for piles, etc. Pile clamps, rectal specula, needle holder, vulsellum forceps, curved needles, petticoat tube and Group I.

XIX.—For operations on gall-bladder. Cholecysto-tomy forceps, gall-stone scoop and Group XIII.

XX.—For operations on kidney. Pedicle clamp, retractors, renal calculus forceps, scoop, sound, pedicle needle, nephrectomy needle, nephrectomy scissors, fine trocar and canula, dilating lance forceps, fine pointed scissors, pus seeker, fine pointed director and Group XIII.

XXI.—For suprapubic cystotomy. Catheters, syringes, irrigation apparatus, hollow sound (Thomson's), sharp hook, long curved forceps, lithotomy forceps, straight and curved of different sizes, lithotomy scoops (stone), blunt hook, retractor, fully curved needles, needle holder, long bladed scalpel or straight bistoury, vulsellum, needles on handles with protected and concealed eyes and Group I.

XXII.—For litholapaxy. Lithotrites of different sizes, evacuators, evacuating canulæ of assorted sizes, sounds irrigation apparatus, rubber tube, Jacque's catheter.

XXIII.—For prostatectomy. Same as in Group XXI.

XXIV.—For internal urethrotomy. Internal urethrotome, catheters, syringe, bougies.

XXV.—For external urethrotomy. Wheelhouse staff, long straight bistoury, Teal's probe-pointed director, probe gorget, median grooved staff, Syme's staff, perineal tube, (metallic) of different sizes and Group I.

XXVI.—For amputation of the penis. Fine toothed forceps, rubber tube, clamps, curved]needles, Jacque's catheters and Group I.

XXVII.—For castration. Clamps, dissector and Group I.

XXVIII.—For operations on hydrocele. Scraper, spoon and Group I.

XXIX.—For elephantiasis.· Retractors, clamps, tissue forceps and Group I.

XXX.—For lymphangioplasty : for hydrocele. Medium size trocar and canula, long and straight needle, silk and catgut and Group I.

XXXI.—For subcutaneous tenotomy. Sharp or blunt pointed tenotome, sutures.

XXXII.—For open tenotomy. Blunt hooks and Group I.

XXXIII.—For intravenous injection. Canula, india-rubber tubes, graduated flasks, elastic tubes, aneurysm needles and Group I.

CHAPTER XXXI.

RECOGNITION AND USE OF INSTRUMENTS.

THE operation assistant should know the instruments that are required for each operation. He should also have acquired a knowledge of the use of the instruments. They should be brought in one lot and arranged in the order of sequence in which they will be required. In handing over the instruments, these should preferably be held by means of a pair of Cheatle forceps. In the absence of Cheatle forceps they should be held in such a way that cutting parts and parts coming in direct contact with the wound are not touched by the assistant's hands. The significance of this warning is obvious.

I. – General Instruments.

(1) Scalpel, should have a sharp point and a good bellied blade.

(2) Dissection Forceps, for separating tissues (Fig. 94).

(3) Artery Forceps (Spencer-Well's). These serve as a temporary means for stopping hæmorrhage till the vessel is permanently occluded by torsion or ligature (Fig. 95).

(4) Scissors. There should be at least two pairs, one for cutting sutures, ligatures, etc. and another for the tissues.

(5) Director (Fig. 96). This serves two objects, as a probe and also as a protector for the soft tissues ; when cutting along its groove, point the cutting edge of the knife away from the groove and do not cut down on the groove or it will damage the edge of the knife.

(6) Needles, straight and curved.

(7) Wound retractors. These may be either single or double ended (Fig. 111).

II.—Instruments for ligature of vessels.

(8) Aneurysm needle for passing a ligature round a vessel after it has been separated from its sheath. It is best passed unthreaded and a good needle should, therefore, have a sufficiently large eye so that it can be easily threaded after it has been passed round the vessel (Fig. 97).

(9) Blunt hook for retracting tendons, nerves, etc.

(10) Dissector for fine dissection and separation of soft tissues from important structures.

III.—Instruments for amputation.

(11) Amputation knife. This should be sharp pointed and single edged (Fig. 98). Double edged knives have no special advantages and are dangerous. The handles should be made for a firm grip and be well-balanced with the blade.

(12) Amputation flap retractors. These may be of two kinds (a) gauze retractor, either double-tailed or three-tailed (Fig. 36) or (b) metal retractors (Fig. 99). The metal retractors are applied by separating the blades entirely and placing one blade so that the bone lies in the apex of its notch. The other blade is then passed to the other side of the limb and pushed into the grooves of the first applied blade, the bone being thus encircled in the retractors. The soft tissues are now protected by the metal blades and can be retracted as desired. A little gauze may be tucked between the retractors and the soft tissues.

(13) Periosteal elevator (Fig. 100).

(14) Rougine (Figs. 101 & 102). This can also be used as a periosteum elevator, it is stronger and sharper.

(15) Amputation saw. This should have an aseptic jointed back (Fig. 103).

(16) Butcher's saw. With this saw less damage is likely to be done to the soft tissues and it also has interchangeable blades (Fig. 104).

Note.—When using an amputation saw most pressure should be applied when it is being drawn towards the operator.

(17) Bone forceps (Figs. 105 & 106), a cutting forcep for bevelling off the sharp edges of the stump after sawing through the bone.

(18) Bone gouge (Figs. 107 & 108) for rounding off sharp edges of the stump.

(19) Bone gouge forceps (Fig. 109).

(20) Lion forceps (Fig. 110) for holding the bone during amputation.

(21) Metacarpal and metatarsal saws. These have long narrow blades so that they can be worked through small spaces between contiguous bones.

IV.—Instruments for special operations.

(22) Artery forceps for torsion. Spencer-Well's forceps have transverse serrations on the inner surface of the jaws and can be used for torsion as well as compression (Fig. 95). They may be straight, angular or angled on flat. Bryant's forceps and its modifications are now out of date.

(23) Fenestrated artery forceps. These crush the vessel in one spot only.

(24) Greig Smith's artery and compression forceps. These have no transverse serrations on the jaws but have a double hawk's bill arrangement and claim superiority over others in not being liable to slip.

(25) Compression forceps. These are similar to Spencer-Well's artery forceps but are heavier and have greater power (Fig. 112).

(26) Pedicle forceps. These are used for crushing pedicles of tumours, for castration, ovariotomy, etc. Kocher's have transverse serrations with teeth at the tip. Jordan Lloyd's are grooved lengthwise. Rutherford Morison's have grooves in two directions crossing each other.

(27) Tissue forceps (Fig. 113) for holding flaps, pulling tissues and fixing towels along the line of the skin incision.

(28) Bullet forceps (Fig. 114). These are of various designs, the one in the figure shows the teeth for round bullets, but

bullets are often flattened out. Use a probe as a guide. . A skiagram is also helpful.

V.—Instruments for suturing.

(29) Suture needles for the skin and soft tissues. These may be bayonet-shaped, *i.e.*, triangular in section or with a bevelled point. They may be straight, half curved, full curved or half circled. They may have a single eye or be spring-eyed to facilitate threading.

(30) Fistula needles. These are similar to any of the above patterns, but shorter and stouter.

(31) Scalp needles. Doyen's flat half curved are the best for this purpose.

(32) Intestinal needles. These should be round-bodied and may be straight, half curved, full curved or half circled. They should always have spring eyes.

(33) Needles in handles. These may be fixed to the handles or inter-changeable. They may be of various angles and have ordinary eyes, slot eyes or spring eyes. They may also be of the " forceps needle " pattern (Carwardine).

(34) Reverdin's needles (Fig. 115). The eyes of these needles are opened and closed by a slide working from the handle.

Note.—Handled needles are useful for hernia operations (Fig. 116), ruptured perineum, transfixion; ligature of pedicles, castration, etc.

(35) Needle holders. These are used for deep sutures and are always necessary for bayonet-shaped or sharp-edged needles, because the latter are liable to cut through the gloves if they slip between the finger while pulling through. Needle holders should be selected with the simplest mechanism as they are easier to keep clean.

(36) Metallic sutures (Mitchell's) (Figs. 117 & 118). These are metal clips for superficial suturing and a set of instruments consists of a pair of spring tenaculum forceps for holding the edges of the wound together and a magazine attached to

same for carrying the clips, compression forceps for applying the clips and extraction forceps for removing the clips.

VI.—Instruments for operations on bones.

(For suturing bones in cases of fracture and for apposing divided bones).

(37) Awls. These may be plain, grooved or tubular with eyes at the end for suturing materials.

(38) Bone drills. These may be used with a bevelled wheel action drill stock or with the ordinary brace (Fig. 119).

(39) Bone holding forceps. These are made in different patterns and sizes for holding the patella and other bones.

(40) Bone lever for raising the fractured ends of bones and apposing them for suturing or plating.

(41) Raspatories (Fig. 120) for stripping the periosteum from the surface of the bone.

(42) Needle for wiring bone.

(43) Wire guides. These are made grooved or tubular and are used for introducing wire through the holes in the bone.

(44) Bone plates, etc :—Staples, clamps, metal plates and screws of different sizes and shapes are used for uniting fractured bones. Some metal plates can be bent in order to adapt them to the bones.

Instruments for resection and excision of bones and joints.

(45) Resection knives (Figs. 121 & 122). These are meant to cut down to the bone through the soft tissues. The handles are large to give a good grip and the blades are short and sharp for strength. Care should be taken that these knives are particularly sharp.

(46) Thread saw (Figs. 123 & 124). With this saw the bones can be excised through a small opening and without damage to the soft tissues. The director is passed through the soft tissues threaded with silk. It is then withdrawn leaving the thread *in situ* and the saw is attached to the silk and drawn into position. The handles are now fixed to the ends of the

saw and·it is worked to and fro, but care must be taken not to bend it at an angle or it is liable to break. These saws are also provided with a spatula-shaped protector· for. the soft tissues. These .saws are useful for excision of the elbow, shoulder and hip, and for resection of ribs, craniectomy, etc. A third handle is useful when the wire breaks (Fig. 124).

Note.—For use on the skull small circular holes are drilled with a quarter inch trephine round the piece of ·bone to be removed and the director with the protector and the saw is then introduced from one hole to the other and the intervening bone is cut from within outward.

VII.—Instruments for trephining, operations on the brain, mastoid and. laminectomy.

(47) Trephines (Fig. 125). These are circular saws which can be worked by hand, hand motor or electric motor. They are of various sizes and some trephines are guarded in order that they may not accidentally work too deep beyond the depth of the skull. For mastoid operations they should be one-eighth inch in diameter and for the skull up to two inches in diameter.

(48) Osteotribes and burrs. These are used in mastoid and other operations for enlarging openings in the bones.

(49) Elevators. These are used for raising the durameter and also in cases of depressed fracture of the skull.

(50) Instruments for enlarging the trephine hole. Gouges, gouge forceps (Fig. 126), and saws (Fig. 127). Hey's or Horsley's saws are recommended, the latter having a convex edge and therefore a larger sawing surface and it is stronger. Gouge forceps (Fig. 126). The mechanism of the gouge forceps should be such that the brain will be protected while the nibbling is carried on from the outer cranial aspects. Dean's, De Vilbiss', Doyen's and Hoffman's are a few of the different varieties. They are so constructed that considerable force can be exerted with the jaws while at various angles.

(51) Instruments for localising operations on the surface of the skull. A rolandometer (Fig. 128) should be used longitudinally on the skull and the short limb which is graduated and at an acute angle should be pointed to the front. In cases of suspected abscess in the brain pus seekers of different kinds are used.

(52) Facial nerve protectors· (Fig. 129). These are used in mastoidectomy operations in order to protect the facial nerve. The nerve lies in the concavity of the tip.

(53) Mastoid gouges (Fig. 130).

(54) Mastoid probes. These are malleable in order that they can be bent in any direction to find out the position of the cavity.

(55) Mastoid scoops (Fig. 131). These and also ring curettes are used for removing debris of bone and granulations.

(56) Mastoid retractors. These have sharp ends and are powerful for retracting the cartilage.

(57) Mastoid ossicle hooks. These are used in the complete operation.

(58) Laminectomy chisels. These have a sharp bevelled edge with a spur at one end and are made for use on the right or left side.

(59) Laminectomy saws. These saws can be fixed to the handle at any angle.

(60) Laminectomy rasps. These can also be fixed to the handle at any angle.

VIII.—Instruments for operations of the nose, pharynx, larynx, œsophagus, etc.

(61) Adenoid curettes. These generally have a straight shaft, but in some cases are fixed at an angle to the handle. Some have sharp hooks attached to a cage which is fixed by a hinge to the shaft. These are meant to catch the growth and prevent it from dropping into the air passages.

(62) Adenoid punch forceps. These are used for cutting or crushing the adenoids.

(63) Hæmorrhage plugs. These consist of inflatable rubber bags and are used for stopping bleeding from the posterior nares.

(64) Polypi forceps. These are of different sizes and strengths. Some have crocodile jaws, others have longer or shorter blades with an antero-posterior or lateral action.

(64a) Polypi snares. These are instruments by means of which a loop of wire is passed round the pedicle or polypi and on tightening, the polypi come off due to a crushing action and bleeding is also checked.

(65) Nasal septum forceps. These are for deviated nasal septum. These generally have smooth and flat blades to hold the septum from either side.

(66) Instruments for submucous resection. Partial resection of the septum by the submucous route is performed by means of instruments designed by Watson Williams and others. They consist of different kinds of knives, raspatories and curettes generally set at different angles in order to raise the submucous flap, then remove the cartilage and finally allow the flap to cover the raw surface.

(67) Turbinectomy instruments. These consist of cutting and punching forceps, saws, gouges, ring knives (plain or with swivel action), guarded knives and scissors of different curves.

(68) Guillotines. For the removal of tonsils, various kinds of guillotines are made. Mackenzie's (Fig. 132) can be supplied with reversible blades, i.e., can be used for right or left tonsil with the right hand. Some guillotines are guarded and fitted with forks to secure the tonsil. The French pattern guillotine has a more or less rounded blade and is fitted with forks.

(69) Tonsil knives (Fig. 133). These have blades of different shapes and sizes either for excision of the tonsils or opening tonsilar and peritonsilar abscesses or slitting open the tonsil in cases of lacunar tonsillitis.

(70) Tonsil bistoury (Fig. 134).

(71) Tonsil scissors (Fig. 135). These are used by some for removing tonsils. Erichsen's scissors have hooks for fixing the tonsil. Other scissors have smaller blades with sharper curves without hooks. When using scissors, tonsils are caught with forceps. These scissors are particularly suitable for the removal of sessile and soft tonsils.

(72) Tonsil punch forceps. These should have stout blades and are useful for vertically elongated tonsils.

(73) Tonsil compression forceps. These are for preventing hæmorrhage after removal of the tonsil and the blades after covering with gauze are placed one inside and one outside the jaw.

Note.—A tongue depressor and a tongue forceps are also necessary for tonsil operations.

(74) Instruments for removal of the uvula. Uvulatomes with sliding action blades. Uvula scissors with long handles and probe-pointed blades. The blades are at an angle to the handle in order that the surgeon's hand is not in the line of his vision.

(75) Instruments for laryngeal growth. Ring curettes are used, working either laterally or antero-posteriorly.

(76) For small growths ecraseurs or laryngeal forceps can be used. Most of these are characterised by being bent rectangularly for adaptability.

(77) Instruments for laryngeal obstruction. These consist of intubation tubes made of vulcanite or metal with an obturator and introducer and an extractor for removing the tubes. The tubes are usually made in seven sizes. A mouth gag (Fig. 136) and tongue forceps are also required.

(78) Laryngotomy canulæ (Fig. 137). These differ from tracheotomy tubes in being shorter and having a flat section and slightly sharper curve in order to adapt themselves to the transverse incision also in order to avoid injuring the vocal cords.

(79) Instruments for tracheotomy. Tracheal dilating forceps (Fig. 138) are a simple cross-action spring forceps, the

blades of which are olive ended or blunt pointed and form a more or less obtuse angle with the handle.

(80) Tracheotomy canulæ (Fig. 139). These consist of an inner male tube and an outer female tube, the latter having a flange with slots for tapes to pass through for tying round the neck. To the flange of the inner tube is fixed an arrangement for easy withdrawal and cleaning of the tube. The outer tubes may be of one piece (Bryant's) or flexible (Howse's). The inner tube may be of one piece (Bryant's) bivalve (Fuller's), or lobster curved (Durham's). Tracheotomy tubes are generally made in eight sizes. There are also india-rubber canulæ which can be used to replace the metal tubes a few days after the operation. These correspond in sizes. Tracheal dilators are not required to be used with the bivalve canula. Sharp hook (Fig. 140) should be fixed to the cricoid cartilage in order to steady the trachea. Double blunt hooks may be used as retractors.

(81) For cases of cut-throat with transverse wound in the trachea 'T-shaped' tracheal tubes are used. They can be introduced in two halves above and below the part where the two halves of the horizontal limbs meet, and are kept in place by slipping on to them another tube with a screw arrangement for fixing.

(82) For constriction of the œsaphagus, bougies are used. These are made of gum elastic or silk web. Their ends may be bulbous, conical or cylindrical. Catgut bougies are used only as guides. Bougies are also made of whale-bone with metal olive ends of various sizes for screwing on to same.

(83) Œsophagotomes. These are knives provided with flexible metal sheaths.

(84) Œsophageal forceps. These are made with blades which open either laterally or antero-posteriorly and are used for removing foreign bodies.

(85) Probangs. These are instruments for removing small foreign bodies and consist of a long flexible stem or shaft with a bristle attachment at one end which is made to expand

in an umbrella fashion from the handle. These are particularly useful for fish bones, etc. For coins a coin-catcher is used. It consists of flexible stem with a double ring at the far end. The free edges of the ring being turned backwards from its attachment so that when introduced into the œsophagus, it passes the coin but on its return journey the coin is caught in the free loop of one of the rings.

IX.—Instruments for operations on the mouth and jaws.

(86) For hare-lip, special forceps for controlling hæmorrhage are used. These may be single with the blades at right angles to the shanks or T-shaped with blades made to compress the vessels on both sides with one pair of forceps.

(87) Hare-lip pins. These are now seldom used. They consist of long needles, the point being sharp and flattened at one end and a knob at the other.

Instruments for the operation of cleft palate.

(88) Forceps which are long and fine, the jaws being serrated or with tenaculum points (Fig. 141).

(89) Hooks.

(90) Knives with short blades and long shafts, the former being at various angles to the shaft. In some cases the blades are double-edged (Smith's).

(91) Cleft palate needles. Small handles may be used with long needle holders (Lane's), or needles on handles of various curves may be used.

(92) Respatories set at different angles (Fig. 101).

(93) Angular scissors with blunt and sharp points.

(94) Silver wire, wire twister and wire cutter. For excision of the upper and lower jaws the usual bone instruments are required, e.g., bone cutting forceps, thread saws (Fig. 123), metacarpal and metatarsal saws, periosteal elevator, sequestrum and lion forceps.

(95) Tooth forceps.

(96) Sponge holder   (Fig. 142).

(97) Bone drills.

(98) Cheek retractor   (Fig. 143).

X.—Instruments for operations of empyema.

(99) Stout scalpel or excision knife.

(100) A periosteal elevator with convenient angle for elevating the periosteum from the inner side of the rib.

(101) A small Hey's or Horsley's saw (Fig. 127).

(102) A thread saw with protector (Fig. 123).

(103) Empyema tubes with arrangement for fixing.

(104) Rib-shears or rib-cutting forceps consists of a bone-cutting forceps which works in scissors fashion. Of the two blades one is sharp and the other is deeply grooved and bent in such a fashion that the grooved side is concave towards the sharp blade, and the other side is conveniently smooth and corvex. The sharp blade fits into the groove of the other blade. In order to cut a rib the blades are opened, the blunt blade introduced under the rib with the grooved edge uppermost and the convex smooth edge towards the pleura. On apposing the blade the rib is cut. The handles of the shears act on a convenient spring (Fig. 144).

XI.—Instruments for operations on stricture
of the urethra.

(105) Teal's probe-pointed director. It is a grooved director with the upper third from the tip shaped like a olive-ended probe. It is introduced through the strictured portion of the urethra after dividing it. The probe gorget is then introduced guided by the groove of the director (Fig. 145), and then the perineal drainage tube (Fig. 148) is introduced.

(106) Fistula director is a probe-pointed director of the Teal pattern. It is of lighter weight (Fig 146).

(107) Wheelhouse staff consists of a straight grooved staff with the groove running for its whole extent excepting for about ¼″ at the tip ; at this point it has a smooth blunt hook directed

towards the non-grooved side of the staff. The groove is utilised for cutting down on the urethra distal to the stricture, after which the staff is reversed and the hook is used as a retractor (Fig. 147).

(108) Lister's bougie (Fig. 149). These are of solid steel, nickel-plated. These are so graduated that the diameter increases by three sizes from the tip upwards, e.g., size $\frac{3}{6}$ means that diameter 3 at the point and 6 at the middle of the shaft in millimeters.

(109) English gum elastic bougie (Fig. 150).

(110) French gum elastic bougie (Fig. 151).

(111) Acorn-headed bougie (Fig. 152), to determine the site and calibre of the stricture.

(112) Miller's bougie (Fig. 153), same use as the last named.

(113) Filiform bougie (Fig. 154), a fine bougie used in cases of narrow strictures.

XII.—Instruments for suprapubic lithotomy and lithotrity.

(114) Thompson's hollow sound is a hollow sound with sharp bend and a short beak in order to facilitate exploration of the bladder without injuring its mucous membrane. It has graduations with an indicator which slips up and down. It is introduced into the bladder which is distended by fluid injected through it. The stone can be felt and measured by graduations and the indicator (Fig. 155).

(115) Lithotomy forceps. The blades consist of two scoops which have roughened concave surfaces. One of the handles consist of a complete ring and the other open ring to facilitate handling (Fig. 156).

(116) Lithotomy scoops. These scoops are of different sizes and the concave surfaces are rough. They are usually double-ended (Fig. 157).

(117) Lithotrite consists of two blades, a male and a female. The former fitting into a groove of the latter. The

blades can be locked by a slider or screw. The two blades can be approximated either by a sliding movement or by screwing movement after they are locked. The stone is gripped by working the blades with a sliding movement. The lithotrite is then locked and the stone crushed by the great force that can be exerted by a screwing movement. The lithotrite should be apposed and locked before its introduction and withdrawal (Fig. 158).

(118) Evacuator. After crushing the stone the bladder is filled by means of an evacuating canula (Fig. 160) which has a sharp bend and short beak and broad slot eye near the tip. The evacuator (Fig. 159) is filled with liquid and adapted to the canula water-tight, through which the bladder and evacuator communicates ; when the bulb of the evacuator is squeezed the fluid in the evacuator is forced into the bladder, and on relieving the pressure the fluid in the bladder containing the stone is aspirated in the evacuator. By means of a valvular arrangement the fragments received in the evacuator is prevented from returning in the bladder.

XIII.—Tenotomy.

(119) Tenotomy knives (Figs. 161 and 162). These consist of narrow bladed sharp and blunt knives. The puncture is made with the sharp one and then the cut is made with a blunt tenotome (Fig. 162).

XIV.—Herniotomy.

(120) Hernia needle (Fig. 116). These are handled needles of different curves. They are meant for apposing the conjoined tendon and Poupart's ligament.

(121) Hernia director (Fig. 163). This is a broad director with shallow groove and is introduced behind the constriction at the neck of the hernia with grooved end towards the constriction. The constricting band is divided by cutting down on the groove.

XV.—Instruments for operation on piles.

(122) Pile clamps. It is used for clamping piles before excision.

(123) Petti-coat tube. This consists of rubber or metal tube round which a piece of gauze is tied in a petti-coat fashion (Fig. 164).

APPENDIX.

$\frac{1}{2}$ Sc
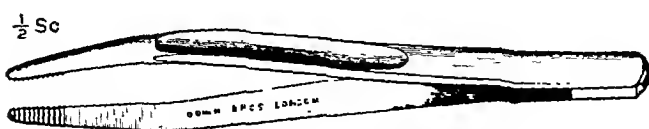
Fig. 94.—Dissection forceps.

$\frac{1}{2}$ Sc
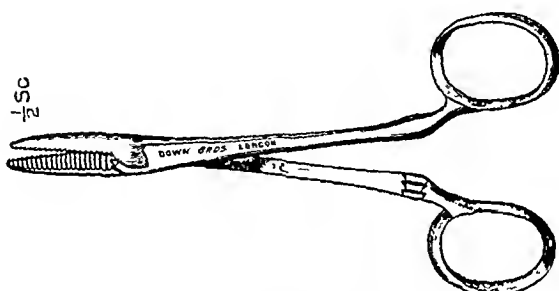
Fig. 95.—Spencer-Wells artery forceps.

$\frac{1}{2}$ Sc

Fig. 96.—Director ear scoop.
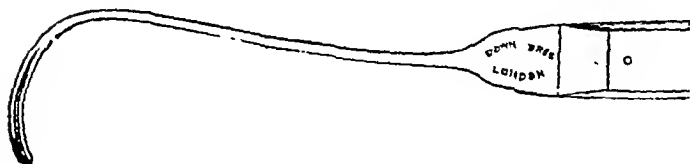
Fig. 97.—Aneurysm needle.
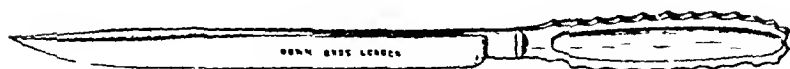
Fig. 98.—Amputation knife.
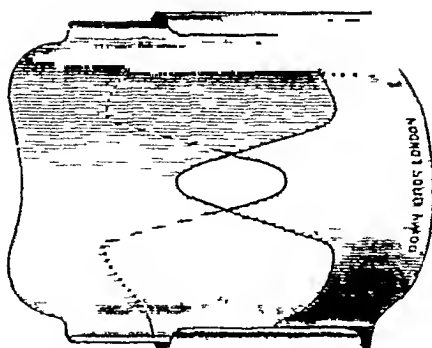
FIG. 99.—Amputation flap retractor.
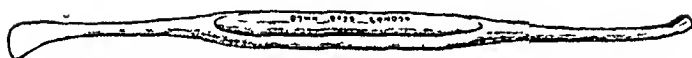
FIG. 100.—Raspatory (periosteal elevator).

FIGS. 101 & 102.—Rougines straight and curved.

$\frac{1}{4}$Sc
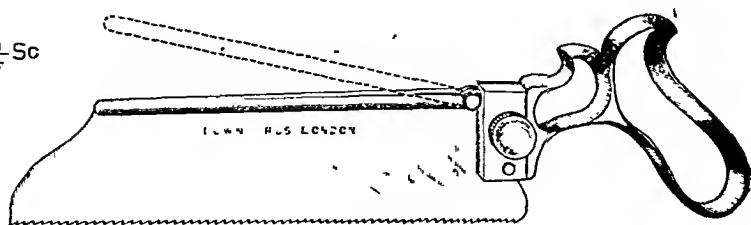
FIG. 103.—Amputation saw.
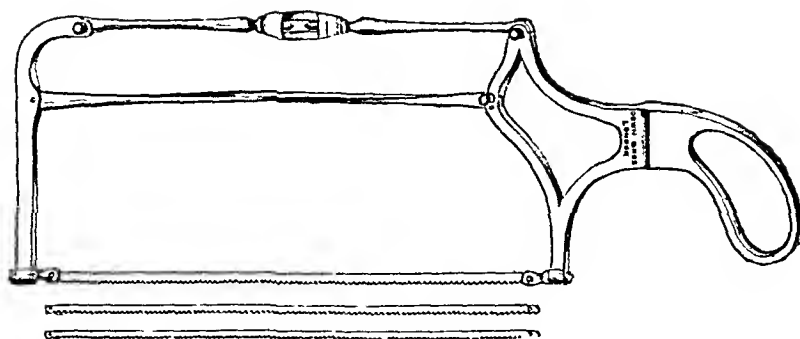
FIG. 104.—Butcher saw.

$\frac{1}{2}$ Sc

FIG. 105.—Bone forceps (flat angle).

$\frac{1}{3}$ Sc
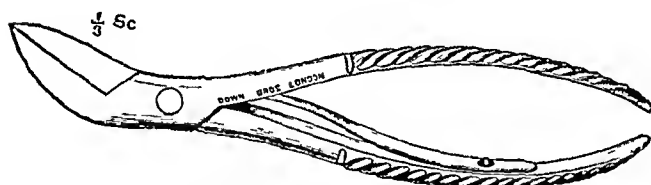
FIG. 106.—Bone forceps curved.

$\frac{1}{3}$ Sc

FIG. 107.—Bone gouge.

$\frac{1}{3}$ Sc

FIG. 108.—Bone gouge.
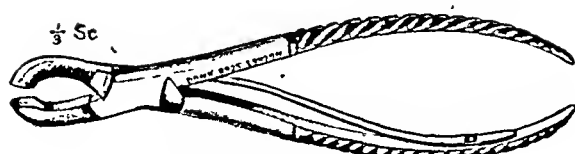
FIG. 109.—Gouge forceps.
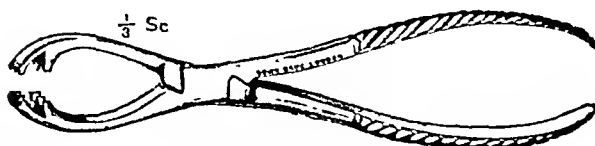
FIG. 110.—Lion forceps.

FIG. 111.—Wound retractor (double ended).
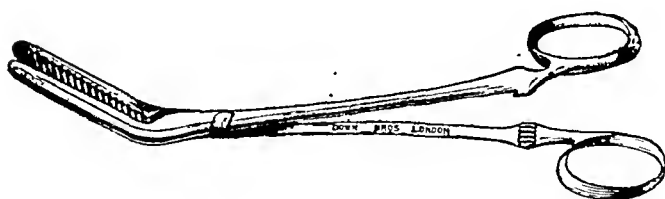
FIG. 112.—Compression forceps (angle or flat).
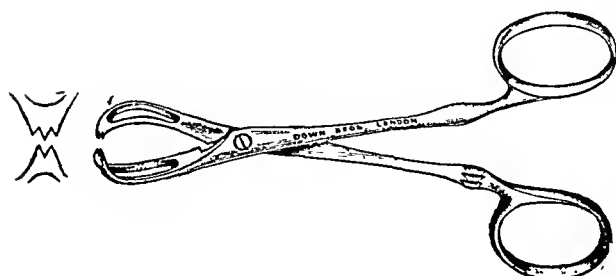
FIG. 113.—Tissue forceps.

FIG. 114.—Bullet forceps.

CLOSED

OPEN

FULL SIZE
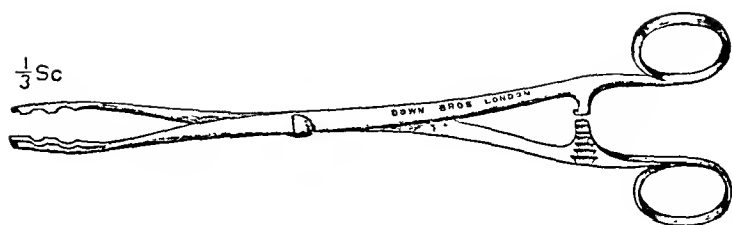
FULL SIZE
CURVES OF NEEDLES
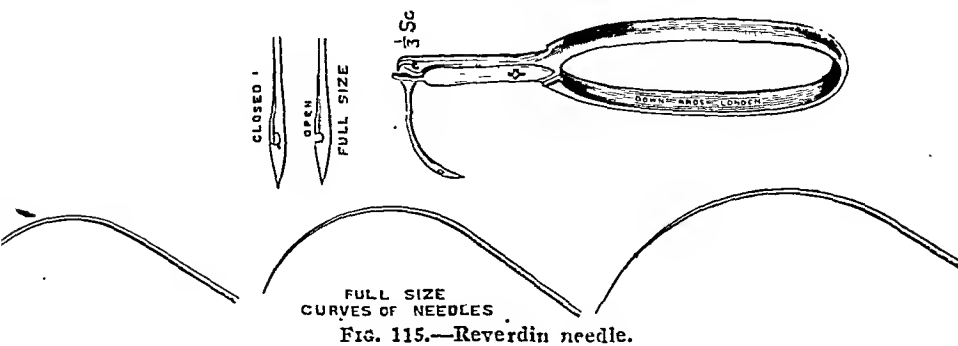
FIG. 115.—Reverdin needle.
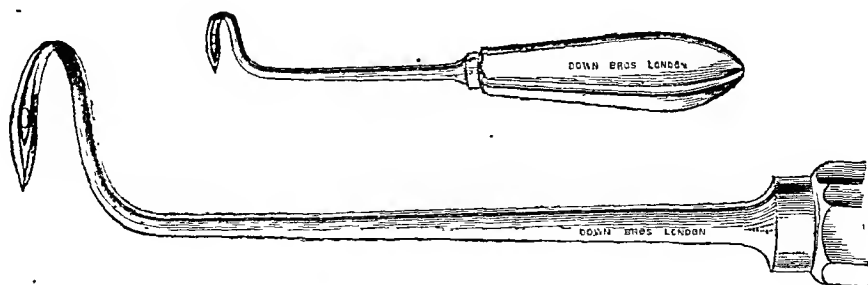
FIG. 116.—Hernia needles.
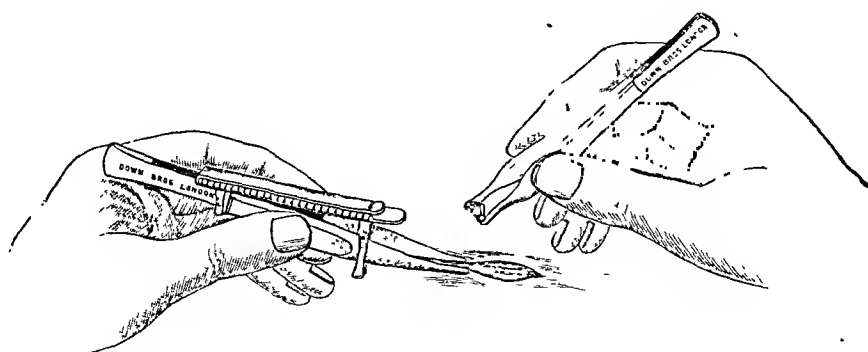
FIG. 117.—Mitchell's clip.
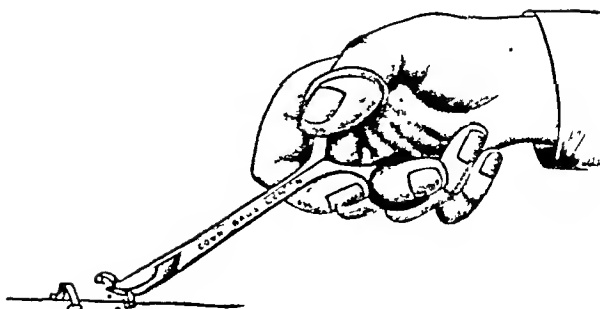
Fig. 118.—Mitchell's clip.
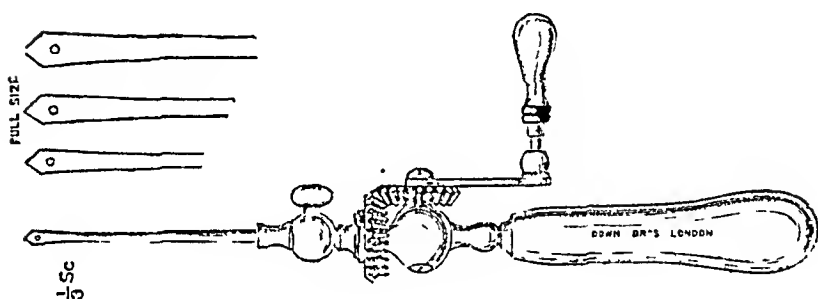
Fig. 119.—Bone drill.
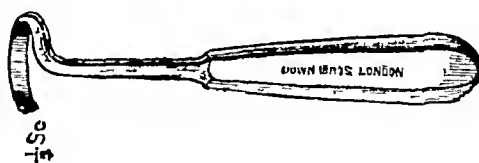
Fig. 120.—Raspatory for ribs.

Fig. 121.—Excision or resection knife.

Fig. 122.—Excision or resection knife.

FIG. 124.—Wire or thread saw (third handle).

FIG. 123.—Wire or thread saw.
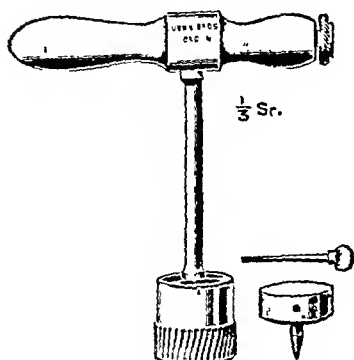
FIG. 125.—Skull trephine.
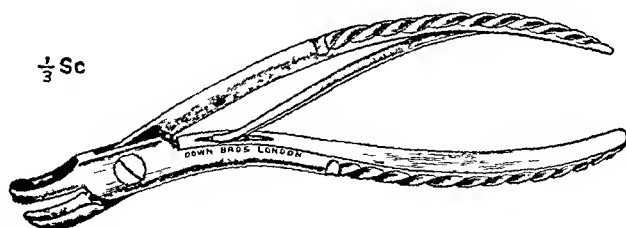
FIG. 126.—Skull gouge forceps.
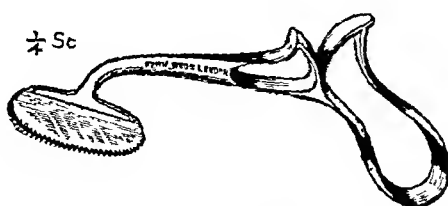
FIG. 127.—Skull saw.
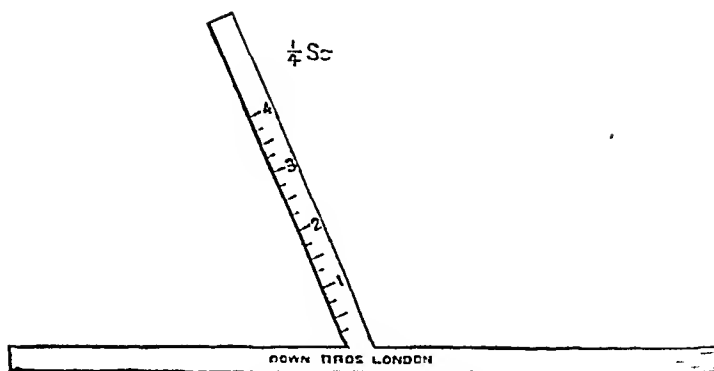
Fig. 128.—Rolandometer.

Fig. 129.—Mastoid guide (Staeckes).
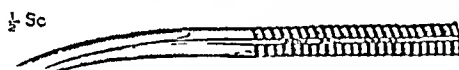
Fig. 130.—Mastoid gouge.

Fig. 131.—Mastoid scoop.
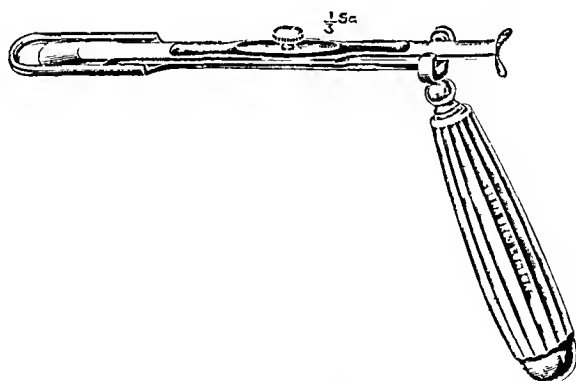
Fig. 132.—Tonsil guillotine.

APPENDIX.

FIG. 134.
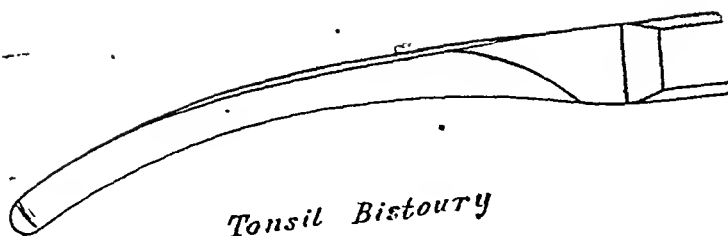
Tonsil Bistoury

FIG. 133.
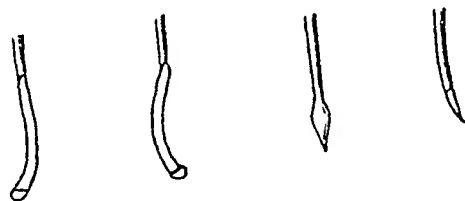
Tonsil Knives.
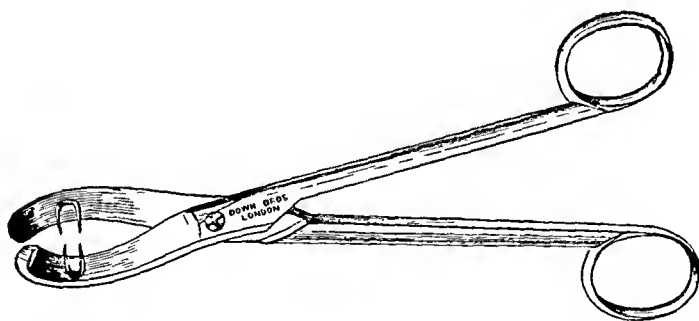
FIG. 135.—Tonsil scissors.
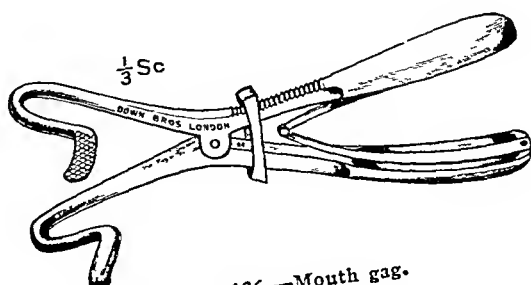
FIG. 136.—Mouth gag.
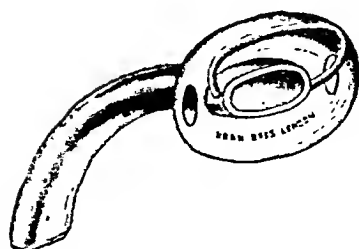
Fig. 137.—Laryngotomy canula.
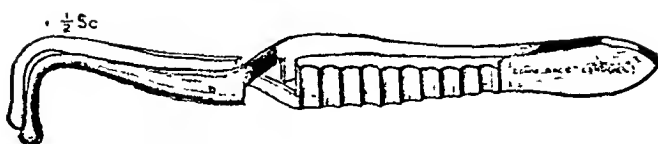
Fig. 138.—Tracheal dilating forceps.
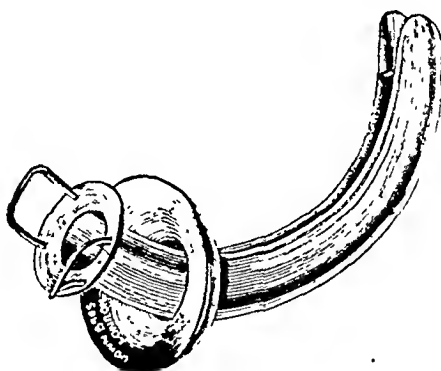
Fig. 139.—Tracheotomy canula.
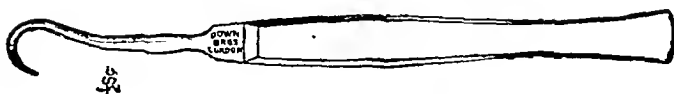
Fig. 140.—Sharp hook.

Fig. 141.—Teal's surgical forceps.

FIG. 142.—Sponge holder.

$\frac{1}{3}$ Sc.
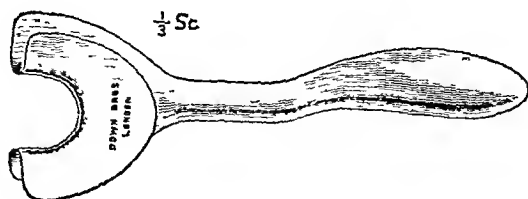
FIG. 143.—Cheek retractor.
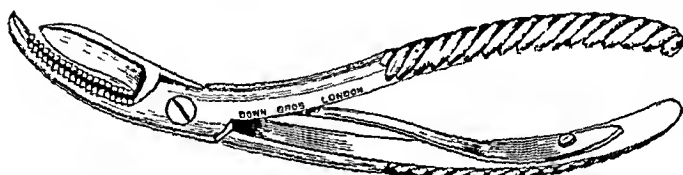
FIG. 144.—Rib shears.
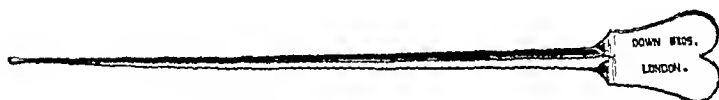
FIG. 145.—Perineal section director.
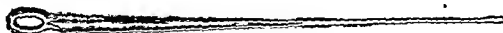
FIG. 146.—Fistula director.

FIG. 147.—Perineal section staff.
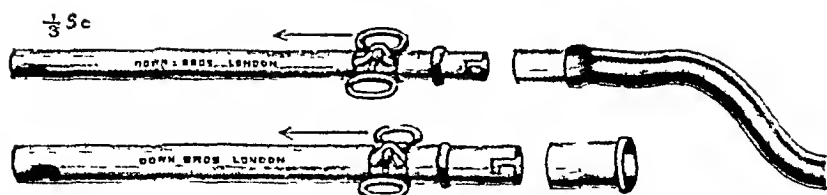
FIG. 148.—Perineal drainage tube.

FIGS. 149.

Lister's Bougie

150.
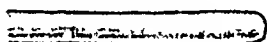
English gum-elastic Bougie

151.
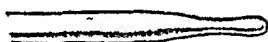
French gum-elastic Bougie

152.
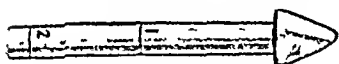
Acorn-headed Bougie

153.

Miller's Bougie

154.

Filiform Bougie

FIG. 155.—Lithotomy sound.

APPENDIX.
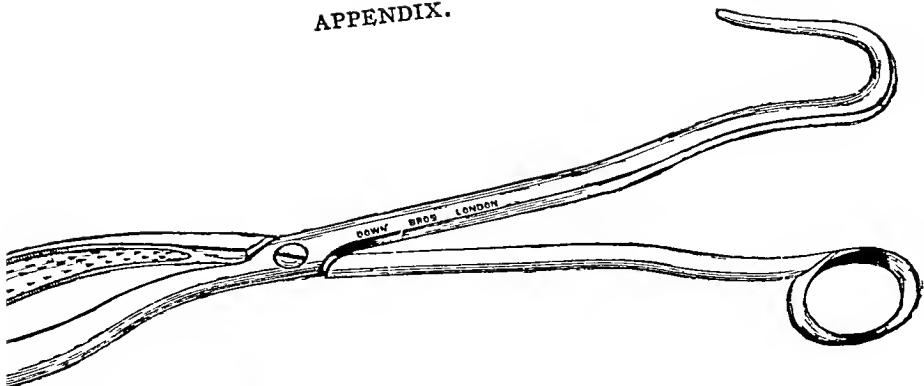
Fig. 156.—Lithotomy forceps.

Fig. 157.—Lithotomy scoop.

$\frac{1}{3}$ Sc

$\frac{1}{3}$ Sc

Fig. 158.—Lithotrite.
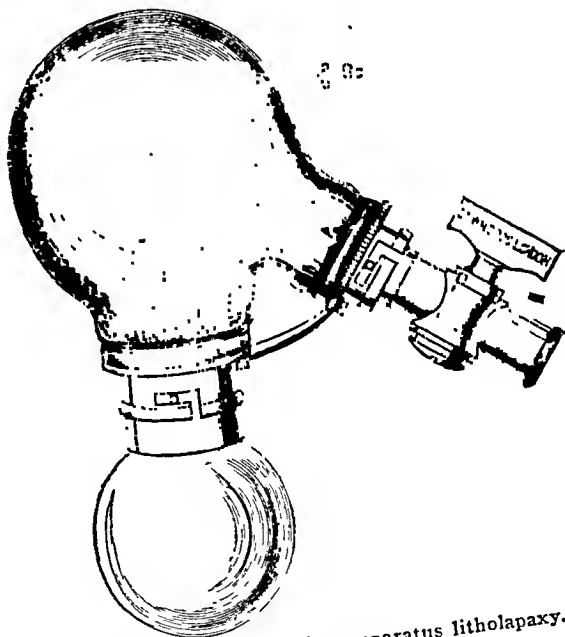
Fig. 159.—Evacuating apparatus litholapaxy.
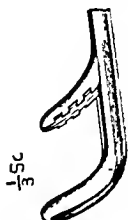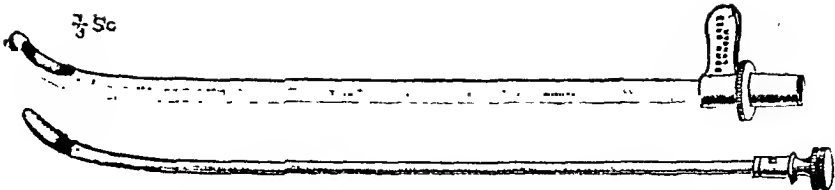
FIG. 160.—Evacuating catheter and pilot.
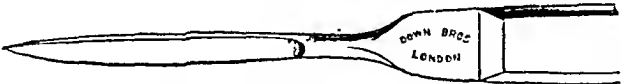
FIG. 161.—Tenotomy knife sharp.
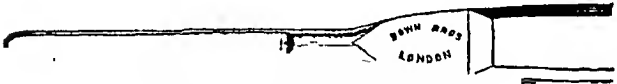
FIG. 162.—Tenotomy knife blunt.

FIG. 163.—Hernia director.
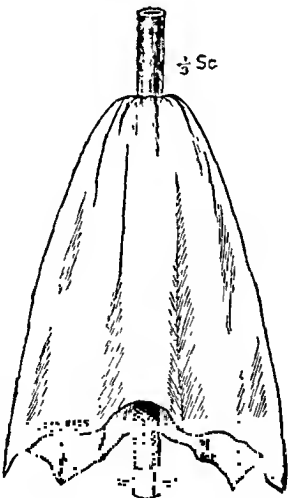
FIG. 164.—Petticoat tube.

A Glossary of the International (B. N. A.) Anatomical Terminology.

IN this volume the old terminology has been adopted as it is in use by English-speaking nations. Below is appended the glossary of the corresponding B. N. A. terms for ready reference, for such readers as are used to it.

THE BONES.

OLD TERMINOLOGY.	B. N. A. TERMINOLOGY.
Ensiform process	Processus xiphoideus
Supra-sternal notch	Incisura jugularis
Frontal	Os frontale
Lateral angular process	Processus zygomaticus
Parietal	Os parietale
Temporal ridges	Lineæ temporales
Groove for lateral sinus	Sulcus transversus
Occipital	Os occipitale
Sphenoid	Os sphenoidale
Spinous process	Spina angularis
Internal pterygoid plate	Lamina medialis processus pterygoidei
External pterygoid plate	Lamina lateralis processus pterygoidei
Cavernous groove	Sulcus caroticus
Temporal bone	Os temporale
Aqueduct of Fallopius	Canalis facialis [Fallopii]
Hiatus Fallopii	Hiatus canalis facialis
Digastric fossa	Incisura mastoidea
Fossa sigmoidea	Sulcus sigmoideus
Glenoid cavity	Fossa mandibularis
Eustachian canal	Semicanalis tubæ auditivæ
Nasal bone	Os nasale
Superior maxillary bone	Maxilla
Facial or external surface	Facies anterior
Antrum of Highmore	Sinus maxillaris
Malar process	Processus zygomaticus
Palate bone	Os palatinum

Old Terminology.	B. N. A. Terminology.
Vertical plate	Pars perpendicularis
Horizontal plate	Pars horizontalis
Malar bone	Os zygomaticum
Zygomatic process	Processus temporalis
Temporo-malar canal	Foramen zygomatico-orbitale
Malar foramen	Foramen zygomatico-faciale
Inferior maxillary bone	Mandibula
Genial tubercle or spine	Spina mentalis
Inferior dental foramen	Foramen mandibulare
Inferior dental canal	Canalis mandibulæ
Spheno-maxillary fossa	Fossa pterygo-palatina
Posterior nares	Choanæ
Sphenoidal fissure	Fissura orbitalis superior
Spheno-maxillary fissure	Fissura orbitalis inferior
Supra-scapular notch	Incisura scapularis
Bicipital groove	Sulcus intertubercularis
Musculo-spiral groove	Sulcus nervi radialis
Internal condyle	Epicondylus medialis
External condyle	Epicondylus lateralis
Greater sigmoid cavity	Incisura semilunaris
Lesser sigmoid cavity	Incisura radialis
Bicipital tuberosity	Tuberositas radii
Sigmoid cavity	Incisura ulnaris
Scaphoid	Os naviculare
Semilunar	Os lunatum
Cuneiform	Os triquetrum
Trapezium	Os multangulum majus
Trapezoid	Os multangulum minus
Os magnum	Os capitatum
Unciform	Os hamatum
Innominate bone	Os coxæ
Superior curved line	Linea glutæa posterior
Spine of the ischium	Spina ischiadica
Great sacro-sciatic notch	Incisura ischiadica major
Lesser sacro-sciatic notch	Incisura ischiadica minor
Descending ramus of pubis	Ramus inferior oss. pubis
Ascending ramus of pubis	Ramus superior oss. pubis
Symphysis pubis	Facies symphyseos
False pelvis	Pelvis major
True pelvis	Pelvis minor
Digital fossa of feuner	Fossa trochanterica
Spiral line ,, ,,	Linea intertrochanterica
Inner condyle ,, ,,	Condylus medialis
Outer condyle ,, ,,	Condylus lateralis
Spine of tibia .	Eminentia intercondyloidea

Old Terminology.	B. N. A. Terminology.
Tubercle of tibia	Tuberositas tibiæ
Internal malleolus	Malleolus medialis
External malleolus	Malleolus lateralis
Astragalus	Talus
Os calcis	Calcaneus
Inner cuneiform	Os cuneiforme primum
Middle cuneiform	Os cuneiforme secundum
Outer cuneiform	Os cuneiforme tertium

THE LIGAMENTS.

Ligaments of the Spine.

Ligamenta subflava	Lig. flava
Odontoid or check ligaments	Lig. alaria

The Jaw.

External lateral ligament	Lig. temporo-mandibulare
Internal lateral ligament	Lig. spheno-mandibulare
Stylo-maxillary ligament	Lig. stylo-mandibulare

Upper Extremity.

Rhomboid ligament	Lig. costo-claviculare
Internal lateral ligament of elbow-joint	Lig. collaterale ulnare
External lateral ligament	Lig. collaterale radiale
Orbicular ligament	Lig. annulare radii
Internal lateral ligament of the carpus	Lig. collaterale carpi ulnare
External lateral ligament of the carpus	Lig. collaterale carpi radiale
Palmer ligaments of the metacarpo-phalangeal joints	Lig. accessoria volaria

Lower Extremity.

Great sacro-sciatic ligament	Lig. sacro-tuberosum
Small sacro-sciatic ligament	Lig. sacro-spinosum
Cotyloid ligament	Labrum glenoidale
Y-shaped ligament	Ligamentum iliofemorale
Ischio-capsular band	Lig. ischio-capsulare
Long external lateral ligament	Lig. collaterale fibulare
Internal lateral ligament	Lig. collaterale tibiale
External semilunar cartilage	Meniscus lateralis
Internal semilunar cartilage	Meniscus medialis
Superior tibio-fibular articulation	Articulatio tibio-fibularis

Old Terminology.	B. N. A. Terminology.
Internal lateral ligament of ankle	Lig. deltoideum
Anterior fasciculus of external lateral ligament	Lig. talo-fibulare anterius
Posterior fasciculus of external lateral ligament	Lig. talo-fibulare posterius
Inferior calcaneo-navicular ligament	Lig. calcaneo-naviculare plantare
Superior astragalo-scaphoid ligament	Lig. talo-naviculare dorsale

THE MUSCLES.

Levator anguli scapulæ	Levator scapulæ
Serratus magnus	Serratus anterior

Muscles of Upper Extremity.

Biceps	Biceps brachii
Brachialis anticus	Brachialis
Triceps	Triceps brachii
Pronator radii teres	Pronator teres
Supinator longus	Brachio-radialis
Supinator brevis	Supinator
Extensor carpi radialis longior	Extensor carpi radialis longus
Extensor carpi radialis brevior	Extensor carpi radialis brevis
Extensor indicis	Extensor indicis proprius
Extensor minimi digiti	Extensor digiti quinti proprius
Extensor ossis metacarpi pollicis	Abductor pollicis longus
Abductor pollicis	Abductor pollicis brevis
Extensor primi internodii pollicis	Extensor pollicis brevis
Extensor secundi internodii pollicis	Extensor pollicis longus
Anterior annular ligament	Lig. carpi transversum
Posterior annular ligament	Lig. carpi dorsale

Muscles of Lower Extremity.

Tensor fasciæ femoris	Tensor fasciæ latæ
Hunter's canal	Canalis adductorius (Hunteri)
Scarpa's triangle	Trigonum femorale
Crural canal	Canalis femoralis
Crural ring	Annulus femoralis
Vastus externus	Vastus lateralis
Crureus	Vastus intermedius
Vastus internus	Vastus medialis
Tibialis anticus	Tibialis anterior
Tendo Achillis	Tendo calcaneus
Tibialis posticus	Tibialis posterior

OLD TERMINOLOGY.	B. N. A. TERMINOLOGY.
Accessorius	Quadratus plantæ
Upper anterior annular ligament	Lig. transversum cruris
Internal annular ligament	Lig. laciniatum
Erector spinæ	Sacro-spinalis
Multifidus spinæ	Multifidus

Muscles of Head and Neck.

Occipito-frontalis	Epicranius
Compressor naris	Pars transversa (nasalis)
Dilatores naris	Pars alaris (nasalis)
Epicranial aponeurosis	Galea aponeurotica
Orbicularis palpebrarum	Orbicularis oculi
Depressor anguli oris	Triangularis
Levator labii superioris	Caput infraorbitale
Zygomaticus major	Zygomaticus
Levator anguli oris	Caninus·
Depressor menti	Mentalis
Platysma myoides	Platysma

Muscles of the Tongue.

Genio-hyo-glossus	Genio-glossus
Superior lingualis	Longitudinalis superior
Inferior lingualis	Longitudinalis inferior

Muscles of the Pharynx.

Azygos uvulæ	M. uvulæ
Levator palati	Levator veli palatini
Tensor palati	Tensor veli palatini

Muscles of Thorax.

Triangularis sterni ·	Transversus thoracis

Muscles of the Abdomen.

Poupart's ligament	Ligamentum inguinale (Pouparti)
Gimbernat's ligament	Ligamentum lacunare (Gimbernati)
Intercolumnar fibres	Fibræ intercrurales
Triangular fascia	Ligamentum inguinale reflexum (Collesi)
External abdominal ring	Annulus inguinalis subcutaneus
Internal pillar	Crus superius
External pillar	Crus inferius
Conjoined tendon	Falx aponeurotica inguinalis
Transversalis muscle	M. transversus abdominis
Fold of Douglas	Linea semicircularis (Douglasi)
Internal abdominal ring	Annulus inguinalis abdominalis

OLD TERMINOLOGY.	B. N. A. TERMINOLOGY.

Perineum and Pelvis.

Transversus perinei	Transversus perinei superficialis
Compressor urethræ	M. sphincter urethræ membranaceæ
Triangular ligament	Diaphragma urogenitale
White line of pelvis	Arcus tendineus fasciæ pelvis
Anterior true ligaments of bladder	Ligamenta puboprostatica

THE NERVES.

Cranial Nerves.

Third nerve	N. oculomotorius
Fourth nerve	N. trochlearis
Fifth nerve	N. trigeminus
Gasserian ganglion	Ganglion semilunare (Gasseri)
Superior maxillary nerve	N. maxillaris
Meckel's ganglion	Ganglion spheno-palatinum
Sixth nerve	N. abducens
Seventh nerve	N. facialis
Auditory nerve	N. acusticus
Jugular ganglion	Ganglion superius
Recurrent laryngeal nerve	N. recurrens
Spinal accessory	Nervus accessorius

Spinal Nerves.

Superficial cervical nerve	N. cutaneus colli
Suprasternal nerves	Nn. supraclaviculares anteriores
Supraclavicular nerves	Nn. supraclaviculares medii
Supra-acromial nerves	Nn. supraclaviculares posteriores
Intercosto-humeral nerve	Nn. intercosto-brachiales
Long subscapular nerve	N. thoraco-dorsalis
Lesser internal cutaneous nerve	N. cutaneus brachii medialis
Cutaneous branch of musculo-cutaneous nerve	N. cutaneus antibrachii lateralis
Internal cutaneous nerve	N. cutaneus antibrachii medialis
Anterior branch	Ramus volaris
Internal branch	Ramus ulnaris
Circumflex nerve	N. axillaris
Anterior interosseous	N. interosseus volaris
Palmar cutaneous branch of the median nerve	Ramus palmaris N. mediani
Collateral palmar digital branches of median nerve	Nn. digitales volares proprii
Dorsal cutaneous branch of ulnar nerve	Ramus dorsalis manus

Old Terminology.	B. N. A. Terminology.
Palmar cutaneous branch of ulnar nerve	Ramus cutaneus palmaris
Musculo-spiral nerve	N. radialis
Upper external cutaneous branch of musculo-spiral nerve	N. cutaneus brachii posterior
Lower external cutaneous branch of musculo-spiral nerve	N. cutaneus antibrachii dorsalis
Radial nerve	Ramus superficialis
Posterior interosseous nerve	N. interosseus dorsalis
Dorsal digital nerves	Nn. digitales dorsales
Genito-crural nerve	N. genito-femoralis
Crural branch of genito-crural nerve	N. lumbo-inguinalis
External cutaneous nerve	N. cutaneus femoris lateralis
Anterior crural nerve	N. femoralis
Long saphenous nerve	N. saphenus
Patellar branch of long saphenous nerve	Ramus infrapatellaris
Great sciatic nerve	N. ischiadicus
External popliteal nerve	N. peronæus communis
Musculocutaneous nerve	N. peronæus superficialis
Anterior tibial nerve	N. peronæus profundus
Internal popliteal nerve	N. tibialis
Nervus communicans tibialis	N. cutaneus suræ medialis
Short saphenous nerve	N. suralis
Internal plantar	N. plantaris medialis
External plantar	N. plantaris lateralis
Pudic nerve	N. pudendus

THE BLOOD VESSELS.

Arteries.

Innominate artery	A. anonyma
Superior thyroid artery	A. thyreoidea superior
Ranine artery	A. profunda linguæ
Facial artery	A. maxillaris externa
Inferior dental artery	A. alveolaris inferior
Small meningeal artery	Ramus meningeus accessorius
Buccal artery	A. buccinatoria
Posterior dental artery	A. alveolaris superior posterior
Arteria comes nervi phrenici	A. pericardiaco-phrenica
Anterior intercostal arteries	Rami intercostales
Thyroid axis	Truncus thyreo-cervicalis
Suprascapular artery	A. transversa scapulæ
Superior intercostal	A. intercostalis suprema
Transversalis colli	A. transversa colli

Old Terminology.	B. N. A. Terminology.
Superior thoracic artery	A. thoracalis suprema
Acromio-thoracic artery	A. thoraco-acromialis
Long thoracic artery	A. thoracalis lateralis
Anterior branch of superior profunda	A. collateralis radialis
Inferior profunda	A. collateralis ulnaris superior
Anastomotica magna	A. collateralis ulnaris inferior
Anterior radial carpal	Ramus carpeus volaris
Posterior radial carpal	Ramus carpeus dorsalis
Dorsal interosseous arteries	Aa. metacarpeæ dorsales
Radialis indicis	A. volaris indicis radialis
Deep palmar arch	Arcus volaris profundus
Posterior interosseous artery	A. interossea dorsalis
Posterior interosseous recurrent artery	A. interossea recurrens
Anterior interosseous artery	A. interossea volaris
Posterior ulnar carpal	Ramus carpeus dorsalis
Anterior ulnar carpal	Ramus carpeus volaris
Superficial palmar arch	Arcus volaris superficialis
Palmar digital arteries	Aa. digitales volares communes
Internal iliac artery	A. hypogastrica
Internal pudic artery	A. pudenda interna
Deep epigastric artery	A. epigastrica inferior
Cremasteric artery	A. spermatica externa
Superficial and deep external pudic arteries	Aa. pudendæ externa
Internal circumflex artery	A. circumflexa femoris medialis
External circumflex artery	A. circumflexa femoris lateralis
Anastomotica magna	A. genu suprema
Superior external articular artery	A. genu superior lateralis
Superior internal articular artery	A. genu superior medialis
Azygos articular artery	A. genu media
Inferior external articular artery	A. genu inferior lateralis
Inferior internal articular artery	A. genu inferior medialis
External malleolar artery	A. malleolaris anterior lateralis
Internal malleolar artery	A. malleolaris anterior medialis
Anterior peroneal artery	Ramus perforans
Posterior peroneal artery	A. malleolaris posterior lateralis
Internal malleolar artery	A. malleolaris posterior medialis
External calcanean artery	Rami calcanei laterales
Internal calcanean artery	Rami calcanei mediales
Internal plantar artery	A. plantaris medialis
External plantar artery	A. plantaris lateralis
Digital branches	Aa. metatarseæ plantares
Collateral digital branches	Aa. digitales plantares

Old Terminology.	B. N. A. Terminology.
Veins.	
Superior longitudinal sinus	Sinus sagittalis superior
Inferior longitudinal sinus	Sinus sagittalis inferior
Suprascapular vein	V. transversa scapulæ
Acromio-thoracic vein	V. thoraco-acromialis
Transversalis colli vein	Vv. transversæ colli
Internal iliac vein	V. hypogastrica
Deep epigastric vein	V. epigastrica inferior
Internal saphenous vein	V. saphena magna
External saphenous vein	V. saphena parva

THE VISCERA.

Digestive Apparatus.

Anterior palatine arch	Arcus glosso-palatinus
Posterior palatine arch	· Arcus pharyngo-palatinus
Stenson's duct	Ductus parotideus (Stenonis)
Bicuspid teeth	Dentes præmolares
Pharyngeal aponeurosis	Tela submucosa
Valvulæ conniventes	Plicæ circulares
Crypts of Lieberkuhn	Gl. intestinales
Ileo-cæcal valve	Valvula coli
Columns of Morgagni	Columnæ rectales
Valves of Houston	Plicæ transversales recti
Peyer's patches	Noduli lymphatici aggregati (Peyeri)

Respiratory Apparatus.

Adam's apple	Prominentia laryngea
Superior thyroid notch	Incisura thyreoidea superior
True vocal cord	Plica vocalis
False vocal cord	Plica ventricularis
Glottis spuria	Rima vestibuli
Thyroid cartilage	Cartilago thyreoidea
Thyro-hyoid membrane	Membrana hyo-thyreoidea
Glottis vocalis	Pars intermembranacea (rimæ glottidis)
Thyroid gland	Glandula thyreoidea
Superior turbinate bone	Concha nasalis superior
Middle turbinate bone	Concha nasalis media
Inferior turbinate bone	Concha nasalis inferior
Antrum of Highmore	Sinus maxillaris

Urogenital Apparatus.

Hydatid of Morgagni (male)	Appendix testis
Vas deferens	Ductus deferens

OLD TERMINOLOGY.	B. N. A. TERMINOLOGY.
Glands of Littré	Gl. urethrales
Cowper's gland	Glandula bulbo-urethralis (Cowperi)
Hydatids of Morgagni (female)	Appendices vesiculosi
Internal os (of uterus)	Orificium internum uteri
External os	Orificium externum
Canal of Nuck	Processus vaginalis
Bartholin's gland	Glandula magna vestibuli

Peritoneum.

Lesser peritoneal sac	Bursa omentalis
Foramen of Winslow	Foramen epiploicum
Costo-colic ligament	Lig. phrenico-colicum
Pouch of Douglas'	Excavatio recto-uterina (cavum Douglasi)

The Ear.

Mastoid antrum .	Antrum tympanicum

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